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INTEL ALDER LAKE ULTIMATE GUIDE

Deep dive into Intel's awesome new CPU

- ✓ Architectural secrets revealed
- ✓ Next-gen rig building
- ✓ Hands-on and no holds barred

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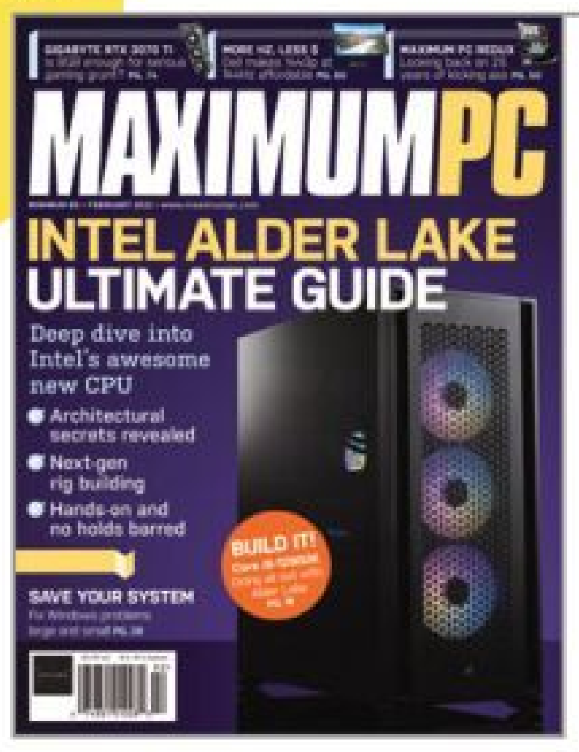
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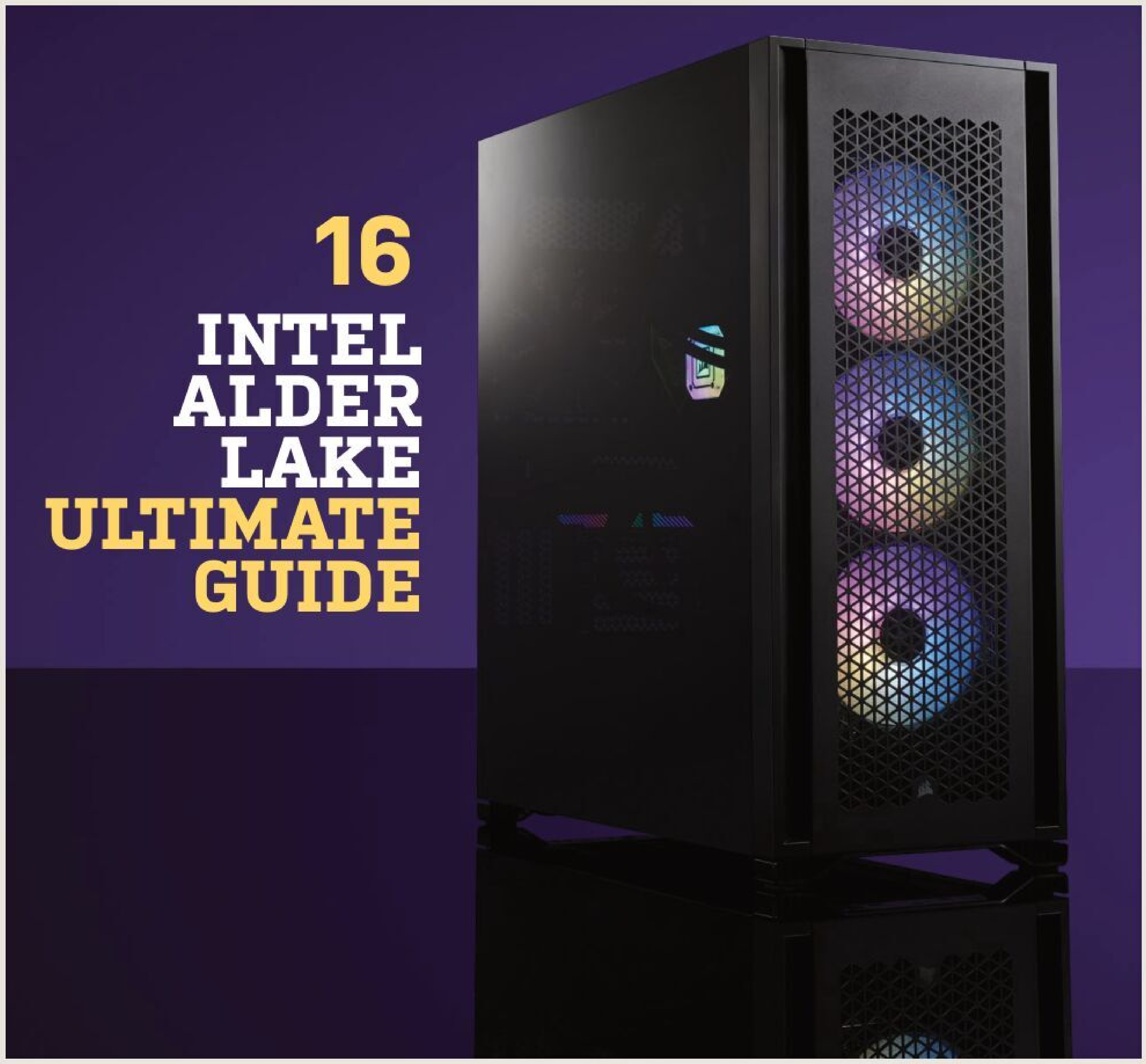

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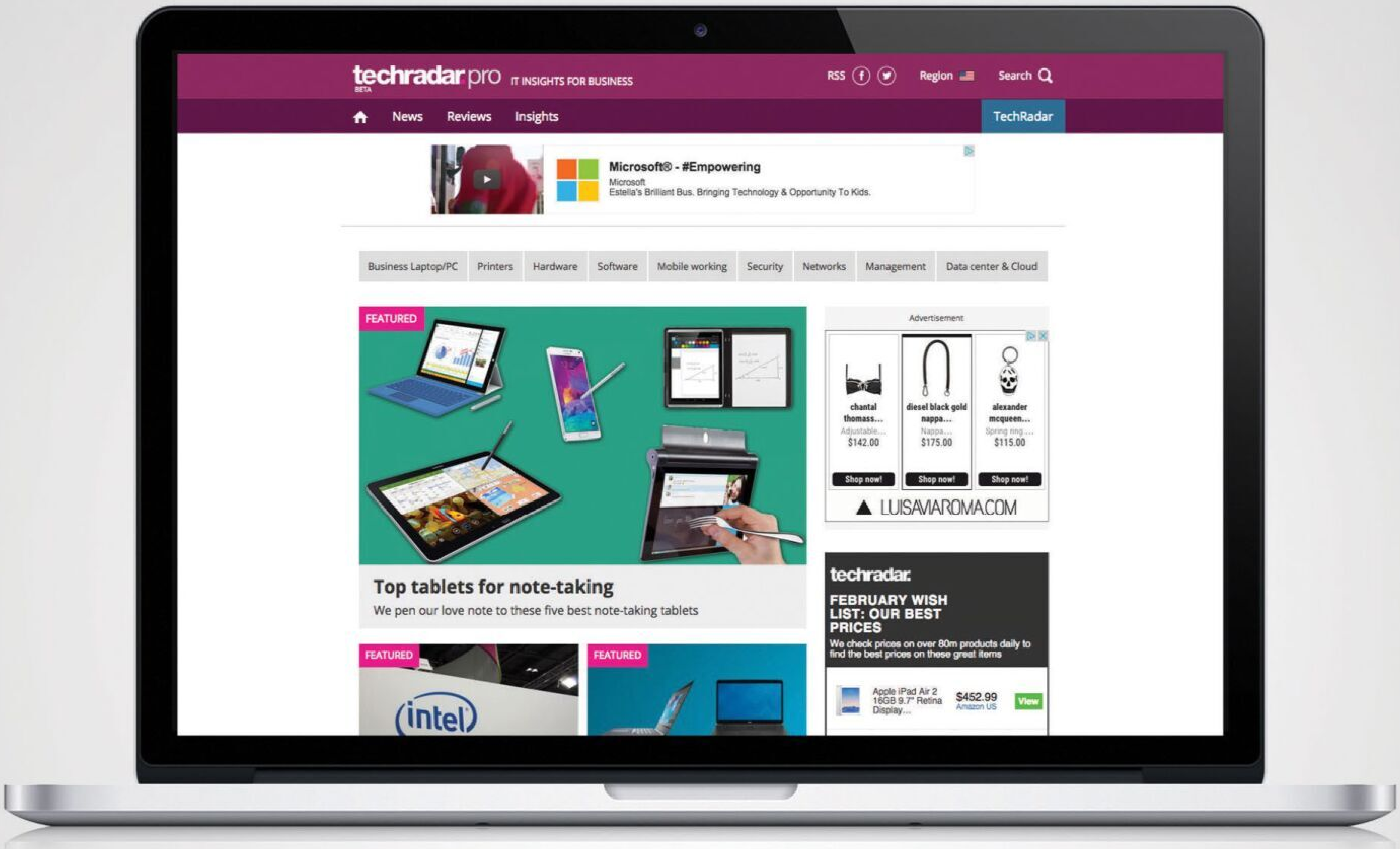

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THE EMPIRE STRIKES BACK

WITH ANY NEW CPU architecture, our first build is always a major landmark. But Intel's Alder Lake is still something special. Not only is it a radical departure from all previous CPUs, what with its hybrid cores, but it also marks the first step in what we hope is a multi-generational return to form for Intel.

As I said in last issue's Lab Notes, I'm not convinced Alder Lake is the CPU Intel originally planned. Problems with Intel's 10nm and 7nm nodes put paid to that. But the benchmarks don't lie and, as our reviews from previous issues and this month's build prove, Alder Lake puts out the numbers. It was great to unleash Sam on our first Alder Lake build, pairing it with some serious GPU power and that hot new DDR5 memory. There's something about running the latest technology that's satisfying, even beyond the raw numbers.

If you want to understand exactly how Alder Lake does what it does, take a look at Jarred's forensic architectural overview, which digs deep into the inner workings of Alder Lake. It's a surprising and innovative architecture on several levels. Did you know that the Gracemont efficiency cores in Alder Lake each have 17 execution ports, five more than the Golden Cove performance cores?

Next up, Nick Peers reboots a signature *Maximum PC* series with his Save Our Systems feature—nine pages of essential advice for fixing Windows problems. Everything from full installation recovery to problems with system sleep and hubs and also including some handy general advice on how to research and solve issues that aren't common enough to pop up in a simple online search.

Our final major feature in this issue involves a retrospective of over 25 years of kicking ass. With a new full-time editor of *Maximum PC* incoming (I'll let him introduce himself next issue) and a new era beckoning, now feels like a good time to look back on how it all started both for the PC and the mag.

Looking back on past issues, it's interesting to see just how quickly *Maximum PC* was honed into the successful formula you see today. It's also pretty funny to peruse the specifications of Dream Machines of yore. We all love to complain about the price of GPUs, and the current situation is ridiculous. But those old builds are a timely reminder of just how much tech you get for your cash today. We all like a little reminiscing, so I hope you enjoy a dip into the archives.

Speaking of having a laugh, Nvidia's GeForce 3070 Ti chipset is a bit of a joke, as Jarred found out. Elsewhere, Sam has been up to his ears in both hardware and software. Highlights include a beginner's guide to music production, an ultra-fast MSI gaming laptop, some slick-looking headphones, and, of course, that Alder Lake build.

As for me, it's been sweet to be back at *Maximum PC* for a few issues getting another fix of the platform I've loved for many years. With any luck, I won't vanish from these pages. So, this is goodbye, but not adieu. Laters.

Jeremy is acting editor-in-chief. He's been writing about PCs for 20 years and enjoys nothing more than a serious dissertation on the finer points of input lag or overclocking.

↘ submit your questions to: editor@maximumpc.com

THE NEWS

Where are our graphics cards?

No relief until the end of 2022

THE GRAPHICS CARD market is in a mess. and that won't change any time soon. Supplies are tight, and every available card is sold the moment it appears. Scalpers scour outlets for stock, and buy everything, only to resell them at inflated prices. And crypto miners are bagging GPUs in bulk. Things have calmed down a little since the summer, but markups of 150-200 percent still sting. According to Nvidia's website prices for a GeForce RTX 3090 should start at $1,399. Currently, the average on auction sites is $1,000 more than that. Finding anybody with stock is another matter.

The latest graphics card launch was a refreshed Nvidia RTX 2060 12GB and aimed at relieving pressure on the market. It uses a 12nm GPU so doesn't compete with the newer cards. It was launched with no fanfare and was immediately sold out. It was thought the elderly 2060 wouldn't be an attractive crypto mining card too, although it transpires it isn't so bad at it after all.

Of course, what we need now is another expensive graphics card you can't get. Nvidia is reportedly readying the RTX 3090 Ti, which employs the GA102 GPU to full effect, this means 10,752 CUDA cores coupled to 24GB of 21Gb/s memory. It was due to appear before the holidays but looks likely for February. It will be horribly expensive if you can even find one.

> Sorry folks, but the card drought looks likely to last a good few months yet.

Are supplies really so tight? According to industry analysts, Jon Peddie Research, there were 12.7 million graphics cards shipped in the third quarter, up from 11.5 million in the previous three months. That's a year-on-year growth of over 25 percent. So where are all the cards going? One culprit that regularly gets the blame are those pesky miners. Nvidia's CFO, Colette Kress, claims that most of its Ampere cards are Lite Hash Rate (although there are ways around this), and it has been selling huge numbers of dedicated mining processors, CMPs which have protected the discrete graphics card market. AMD's CEO, Lisa Su, went a step further and claimed in November that it's "a different market than it was a few years ago with crypto", and that "we don't believe it's a meaningful driver". Forgive us if we are skeptical of this. Crypto mining chews through hardware, and both Bitcoin and Ethereum are currently strong, especially the latter.

We've had a perfect storm of demand. The market for high-end GPUs jumped in PCs, consoles, and servers. The pandemic added more pressure, as people looked around for new kit. It also helped squeeze supplies, as the various lockdowns around the world hit key components. The supply chain is fragile, it is near-impossible to suddenly increase production of high-end silicon. There are only so many chip fabrication plants and demand made an unpredictable jump just as production faltered.

Low supply also means the more important customers get the best treatment, and that isn't the graphics card makers. Meanwhile, this has been sweet for AMD and Nvidia, both of whom had profitable third quarters, reaching year-on-year revenue growth of over 50 percent.

How much longer must we endure this drought? Colette Kress and Lisa Su agree: it won't be until the end of 2022 that supplies improve enough so you can expect to be able to source a card and pay the recommended retail price. Some pundits have suggested there may even be a nice kicker at the end of all this: over-supply in 2023 as the artificial demand eases, we shall see.

Intel's entry into the market can't come soon enough, let us hope it has earmarked decent manufacturing capacity because it will sell everything it makes for a while yet. But the reality is that you need to pay big and search hard because the hard times will be with us for a while. **–CL**

NO GAMING WHILE DRIVING

TESLA WARNED AFTER SOFTWARE UPDATE

TESLA IS IN TROUBLE with the National Highway Transportation Safety Administration after a software update allowed owners to play games whilst driving. Normally only usable in Park, the update removed this restriction for the pre-installed games. You can now play *Sky Force Reloaded* and 18 other games while driving. Click through a warning message saying "Use of Tesla Arcade while the vehicle is in motion is only for passengers" and to "check local laws," and off you go. Teslas are still a long way from self-driving, despite Elon Musk's promises, and if there is one thing you need to do when driving it is to pay attention. This sort of loose play with regulations looks sloppy at best, some would say irresponsible. A software update or recall is expected shortly. Tesla isn't alone either, Mercedes Benz recently had to fix a server bug that enabled you to watch television on the EQS, and S-Class 'hyperscreen' whilst driving. **–CL**

SSD SLOWDOWN

It turns out that Windows 11's sluggishness isn't your imagination

NO MAJOR OPERATING SYSTEM upgrade goes unpunished. The move to Win11 has been mostly smooth, although another wrinkle has emerged: it appears the speed of some SSD drives has been compromised. Specifically, the random write speed has been halved, or worse. Initial reports pointed to Samsung drives, but it appears that all makes are affected except Optane.

Many report that only the drive used to install Win11 suffers, as swapping around drives proves. The upshot is that anything that makes use of random write is going to be significantly more lethargic. The chatter on forums suggests that the trouble isn't new either, there were issues reported with the preview builds of Win11 months ago. Microsoft is aware of the bug and is reportedly "almost ready" with a fix. No doubt there is a long list of bugs to squash, but a performance drop of over 50 percent is quite some hit. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **FUSION POWER GETS REAL**
For the first time, the National Ignition Facility has managed to get a fusion reactor to generate more power than it consumes.

✓ **TEXAS GETS FAB**
Samsung is to invest $17bn in a new chip fabrication plant in Taylor, Texas, as part of a $205bn expansion of production.

✓ **SELF-DESTRUCTING FLASH**
Russian firm Rostec has launched a USB drive with a button that burns them beyond recovery.

TRAGEDIES

✗ **SPACEX IN TROUBLE**
The company's problems with the Rapter engine could mean a "genuine risk of bankruptcy," according to Elon Musk.

✗ **SWITCH HACKER FINED**
Hacker Ken Browser has been ordered to pay Nintendo $14.5m in damages for selling Switch modding kits.

✗ **EDGE DISSES CHROME**
Search for Chrome using Microsoft Edge and dialog pop-ups try to dissuade you. Sneaky!

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INTEL'S ARC ALCHEMIST GPU REVEALED

And then there were three...

AT THE ANNUAL GAME AWARDS, we got a glimpse of Arc Alchemist in action, Intel's first serious discrete graphics card. We saw a handful of top titles running at 1440p, and also saw a 3D rendered card which sported an 8-pin power connector (enough for 150W, so a maximum of 225W with the PCIe power). Whilst Intel is tight on details, there are plenty of engineering samples around and we have some solid details on the GPU dies. There are two: the DG2-SOC1 and DG2-SOC2.

The bigger die is the DG2-SOC1 (about the size of an Nvidia GA104) and comes in versions with either 512, 384, or 256 Execution Units. The 512 version sports 16GB of GDDR6, with 32GB being considered for 'professional' cards. The 384 EU card gets 12GB, and that half chip version has 8GB. SOC1 cards are being pitched against the Nvidia RTX 3060 and 3070, and AMD's Radeon 6600 to 6800: mid-range and up to about $500. SOC1 production is due to start in February, so don't expect to see any cards before April. The smaller die, SOC2, will have two 128 EU versions, one a lower-power version, and a 96 EU variant for low-end kit. It'll use 6GB or 4GB, and draw its power from PCIe. SOC2 production starts in January. With just two dies, Intel aims to cover almost the entire market, but cards in numbers won't arrive until the middle of the year.

Prices? The stated aim of Intel is to be 10 percent cheaper and faster than equivalent Nvidia offerings. Intel's tactic appears to be to establish itself as the third option before going for the crown: the high-end enthusiast cards. We will have to wait, probably until Battlemage in 2023, for that fight. Intel's promotional video opens with the phrase "a new player enters the game". It's not wrong. **–CL**

Intel's DG2 dies prove it is deadly serious about becoming a rival to Nvidia and AMD.

RENT OUT YOUR RIG

Free software, in return for your processing power

REMEMBER WHEN we were asked to donate idle processing power to SETI@Home? Starting in 1999, this distributed computing project analyzed radio signals looking for signs of alien life. The project closed a few years ago (it found no proof) and you got nothing other than a warm glow for helping science. Now distributed computing is a target for money-making.

A start-up called Massive has raised $11 million to fund work on an SDK to enable developers to include the option to pay for their products with donated processing power. You get to use a game or app solely for a donation of your rig's power, which is then sold off to power scientific research projects, block-chain processing, or other distributed tasks.

You don't have to witness annoying adverts, pay a subscription, or shell out for any upfront purchase costs. You can opt out at any point without having handed over a cent. Smaller developers can have a tough time getting remunerated for their work, as little ad revenue filters down, and they often have to become an unwilling part of the great data gathering of the corporations.

The team behind the scheme appears to have an agenda, describing the internet as an "attention-grabbing, emotion-manipulating, privacy-violating experience". Harsh perhaps, but not without merit. Nothing is free of course. Your rig and internet connection may be 'idle', but it is still drawing power. Some math may be required to see if this is a good deal for the long-term use of software, but it's an interesting idea.

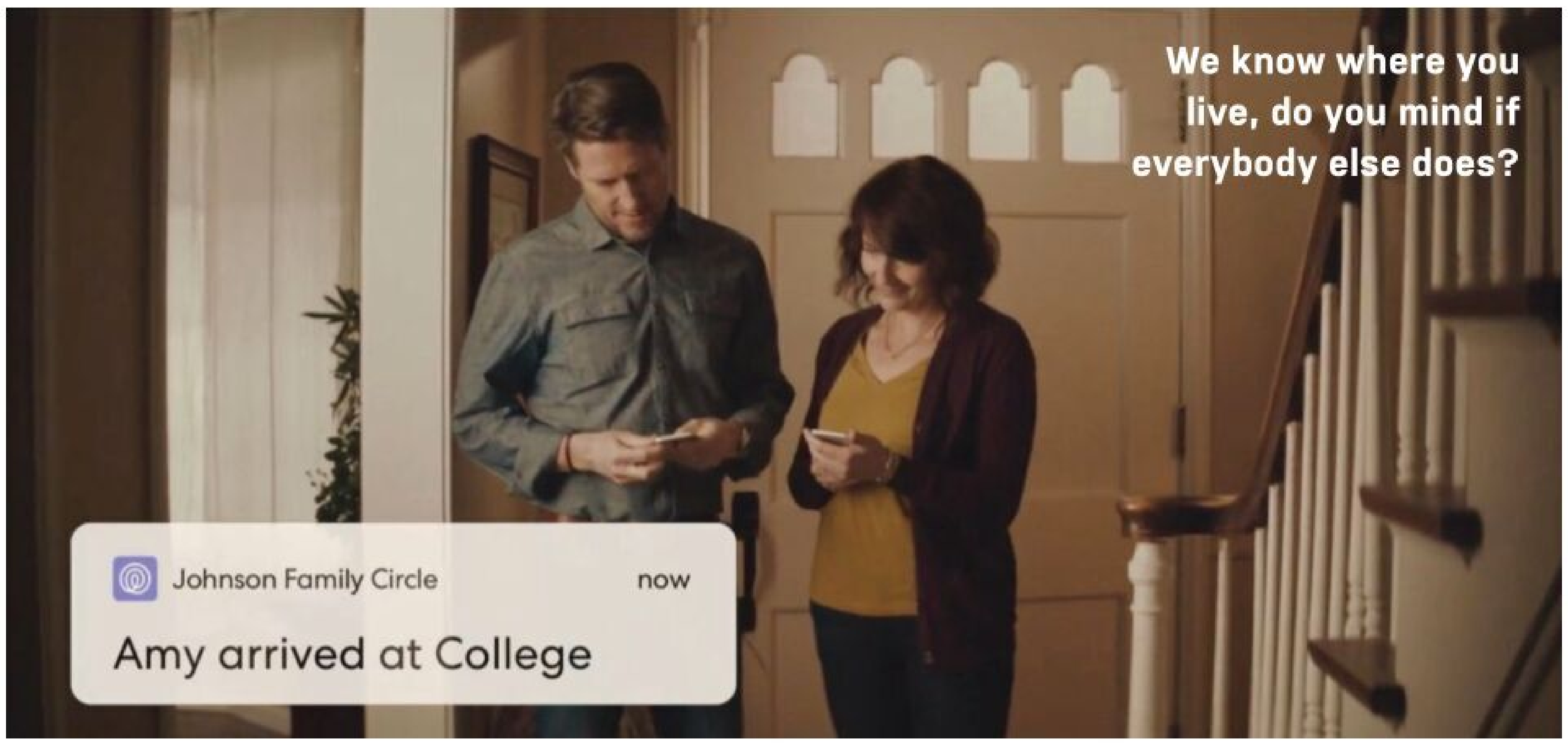
Paying for a game with processing cycles (and contributing to science) rather than having advertisements foisted on you seems a fair exchange, especially if you are evaluating something first. **–CL**

Life360 sells your location data

LIFE360 CLAIMS TO BE the world's leading family safety service. Essentially, it uses your smartphone's GPS to track your movements and sends alerts under specified conditions to designated people. Naturally, this creates a lot of location data, which is quite an asset. Two former employees have revealed that Life360 has been selling it to leading data brokers for years. It transpires that Life360 is one of the largest providers of location data in the country, part of a $12bn phone tracking business.

The privacy policy on the Life360 website says it may share collected data with partners for "tailored advertising, attribution, analytics, research, and other purposes". You can opt out, but by default, it is on. Founder and CEO of Life360, Chris Hulls, said that "we see data as an important part of our business model that allows us to keep the core Life360 services free for users". The truth is that if you don't pay in dollars, you pay in something else, that's why social media is free. Selling the collected data brought Life360 $16-22 million in 2020. Thankfully, your location data is not connected to your identity, although one data point is your home. However, once the data is with a broker, it is available to almost anybody willing to pay for it.

When you give a company data, you have no control over who gets it or what use they make of it. Companies are not even obliged to tell you who buys it, and you usually have to take active steps to keep it private. We shouldn't be surprised that even a company whose stated aim is safety resorts to selling your data. Only legislation can curb these practices, which would be a huge step and a mammoth job to remove. We may not like it, but we may be stuck with it. **–CL**



We know where you live, do you mind if everybody else does?

Stop stealing presents

A bill has been reintroduced to Congress to curb the use of 'grinch bots', that is automated software to scan online stores, and snap up the hot items before anybody else can get them. These are then sold on at a profit to those who missed out, including desperate parents.

The bill's sponsors have called it the 'Stopping Grinch Bots' bill, and claim the "bots ruin the holidays". Bots spoil the fun for PC users too—with supplies of graphics cards tight, scalpers are in full effect. The practicality of the task is considerable, but it has been done before. A bill in 2016, aimed at stopping automated systems from buying tickets to sports events and concerts, has led to prosecutions. **–CL**

Going off track

NordicTrack sells a $3,999 X32i smart treadmill that comes with a superscription training service, $39 per month to provide the encouragement you need. Its 32-inch HD touchscreen can be put to other uses, and some owners had been using the 'privilege mode' to unlock the Android OS and make full use of the hardware.

NordicTrack wasn't happy and, in a new software update, access was blocked. You can work around this with a hard reset and by refusing the update. The real money is in subscription services, not treadmills. However, once you buy hardware, it is up to you what you do with it, although convoluted laws on intellectual rights don't always make this easy. **–CL**

© LIFE 360

Jarred Walton

TECH TALK

Windows 10 vs. Windows 11

OH, WINDOWS 11, how I love to hate you. Change for the sake of change doesn't sit well with me, and Windows 11 has completely altered the comfortable Windows 10 house I've been living in since 2015. A new coat of paint would have been fine, but it seems as though the UI designers also felt the need to rearrange the furniture, switch around the drawers, and clean house a bunch of functionality that I liked. This is not okay.

Context menus now require an extra click to get at the menu I actually wanted, but what's worse is the way some functionality is simply gone. I may be the exception, but I want all my system tray icons to always be visible. I've encountered far too many PCs where more than a dozen 'utilities' are running in the background sucking down system resources. Even worse, some malware sits in the system tray, and hiding icons by default is a terrible idea. On Windows 10 and earlier, there's a simple toggle to show all icons, but Windows 11 killed it.

Other things have changed as well, such as the Microsoft Store—which was updated for Windows 10 users too. Changing the default installation drive used to be easier. Now, I'm not even sure how to move a Store app to a different drive. I didn't like the Microsoft Store before, but the new version if anything feels worse. And there are a few games that require me to use the Store app.

The good news is that the performance hasn't changed between Windows 10 and Windows 11. In fact, for newer PCs running Intel's Alder Lake CPUs (see feature, page 28), you'll pretty much be forced into running Windows 11 whether you want to or not. The hybrid CPU architecture requires a new scheduling algorithm and, for the time being, Microsoft doesn't want to port that back to Windows 10. It's like when AMD and Intel dropped support for Windows 7/8 for Ryzen and 7th Gen processors. If you want a new Alder Lake system, it can use Windows 10, but won't run optimally.

> The performance difference between Windows 10 and Win 11 was less than one percent

Windows 11 might be the future Microsoft currently sees, but there's no penalty to sticking with Windows 10 for the time being.

© MICROSOFT

But what about for people not running the latest and greatest CPUs? Is Windows 11 any better—or worse—than Windows 10? I set about running a bunch of benchmarks on a Core i9-9900K system using an AMD Radeon RX 6900 XT and an Nvidia GeForce RTX 3080 Ti. Both systems had a clean install and all the other hardware remained unchanged, except one has Windows 10 and the other has Windows 11. The results are mind-numbingly boring.

Across a 15-game test suite, the overall performance difference between Windows 10 and Windows 11 at three different resolutions was less than one percent. There were a few differences of up to three percent, but that's basically within the margin of error. Sometimes Windows 10 was a bit faster, sometimes Windows 11 came out ahead. But in practice, there was no significant change. That's great because I'd hate to see the new OS penalize or benefit performance. Maybe I'll adapt over time to the Windows 11 changes, and I do plan on upgrading to an Alder Lake system eventually, so I will basically be forced to make the change during that upgrade. But my old PCs will continue to run Windows 10, even if Windows 11 is a free upgrade, and I can't even begin to imagine trying to get most of my family members and friends to make the switch.

Not that most of them will have a choice in the matter unless they want to buy a new PC. The TPM requirement as well as the need for a relatively modern CPU both eliminate many PCs from upgrading. Perhaps Microsoft was trying to do everyone a favor, but it feels like the old curse of every other Windows version being good. XP was loved, Vista was loathed, Windows 7 regained our trust, Windows 8 flushed it away.

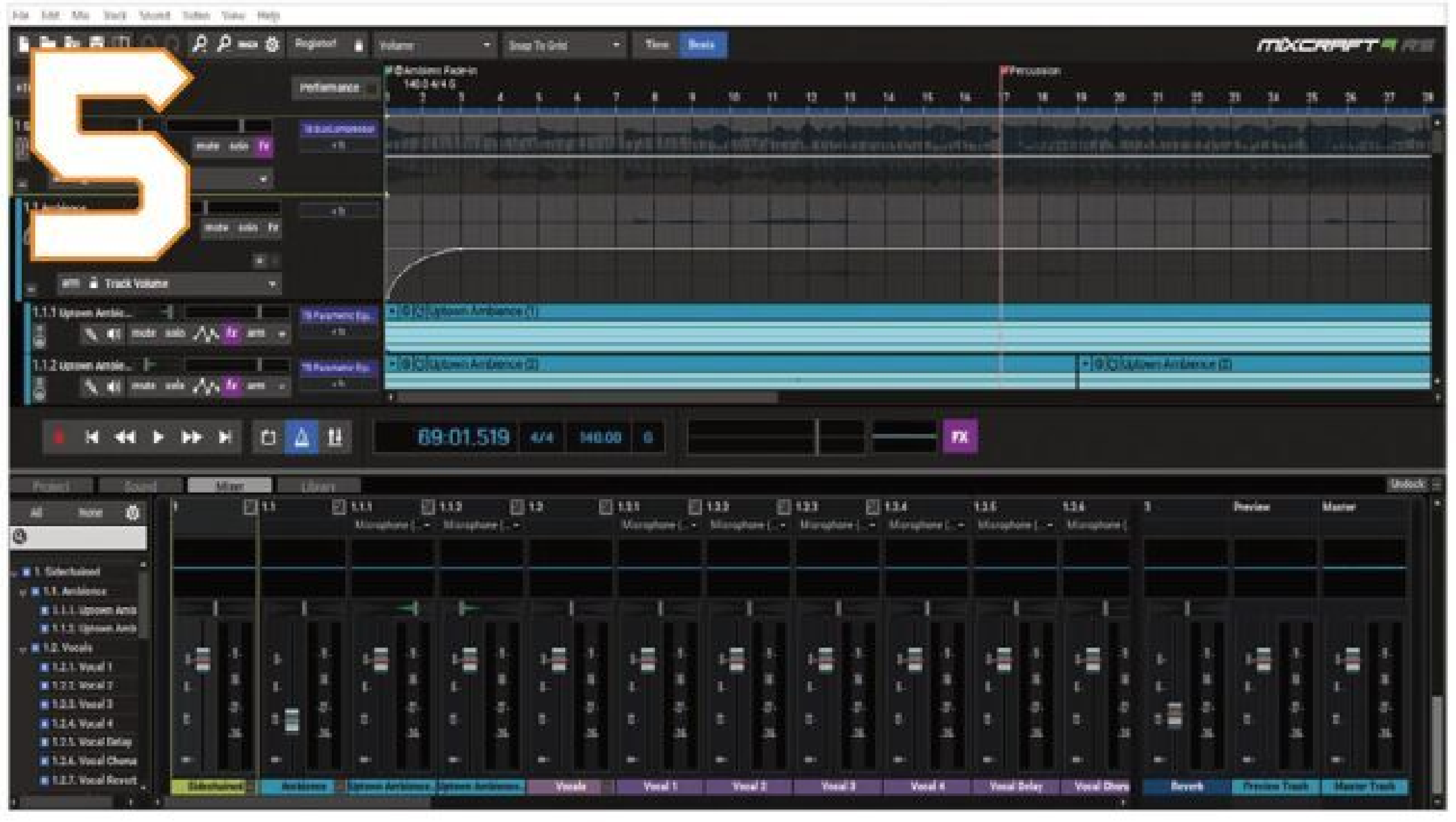
Windows 10 went through numerous updates, and for a while, we all thought it might be the 'last' version of Windows that we'd ever need. Windows 11 brings in a new coat of paint. But, sadly, it has been rather sloppily applied.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

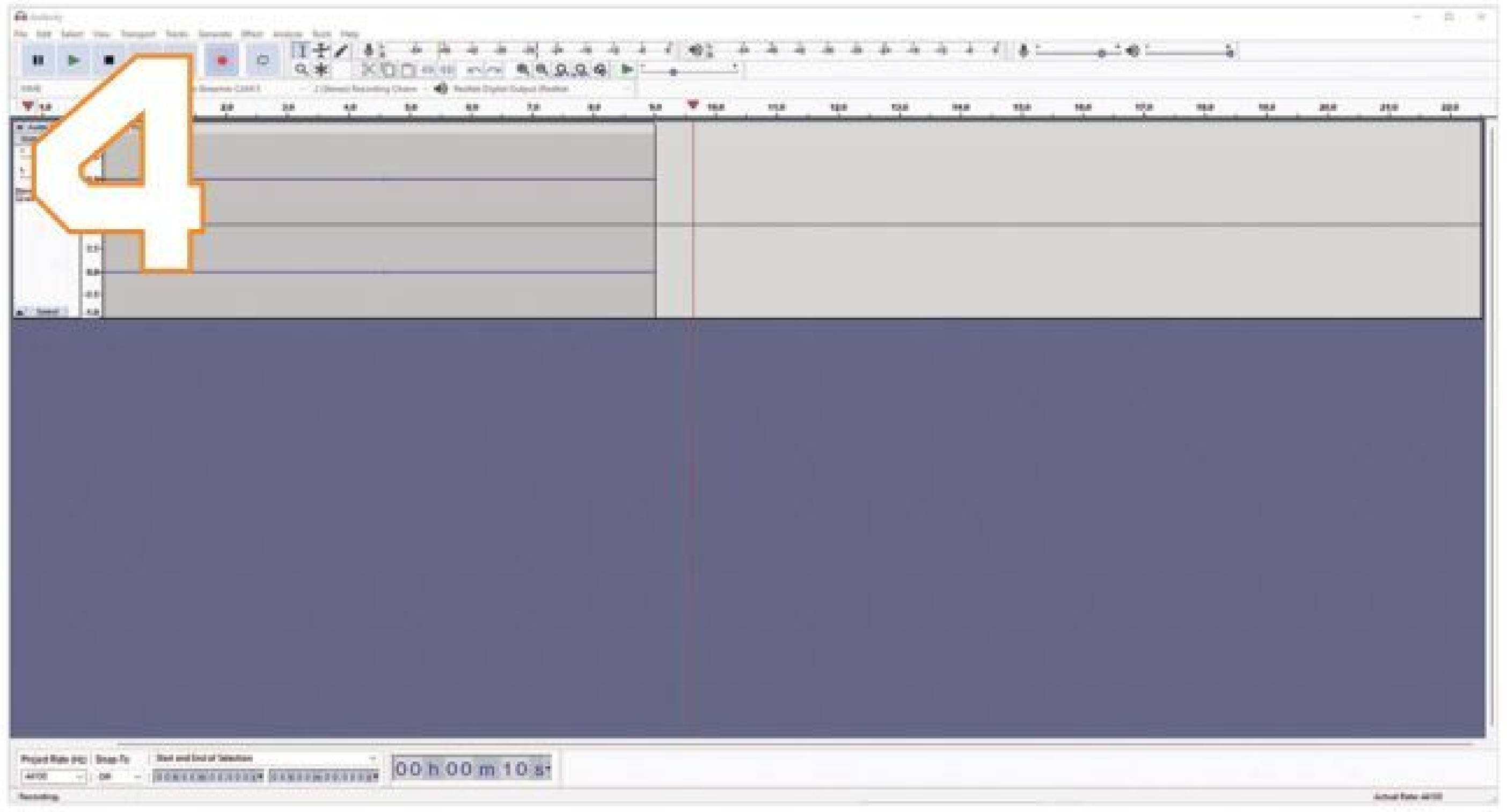
THE LIST

THE TOP FIVE AUDIO PRODUCTION PROGRAMS

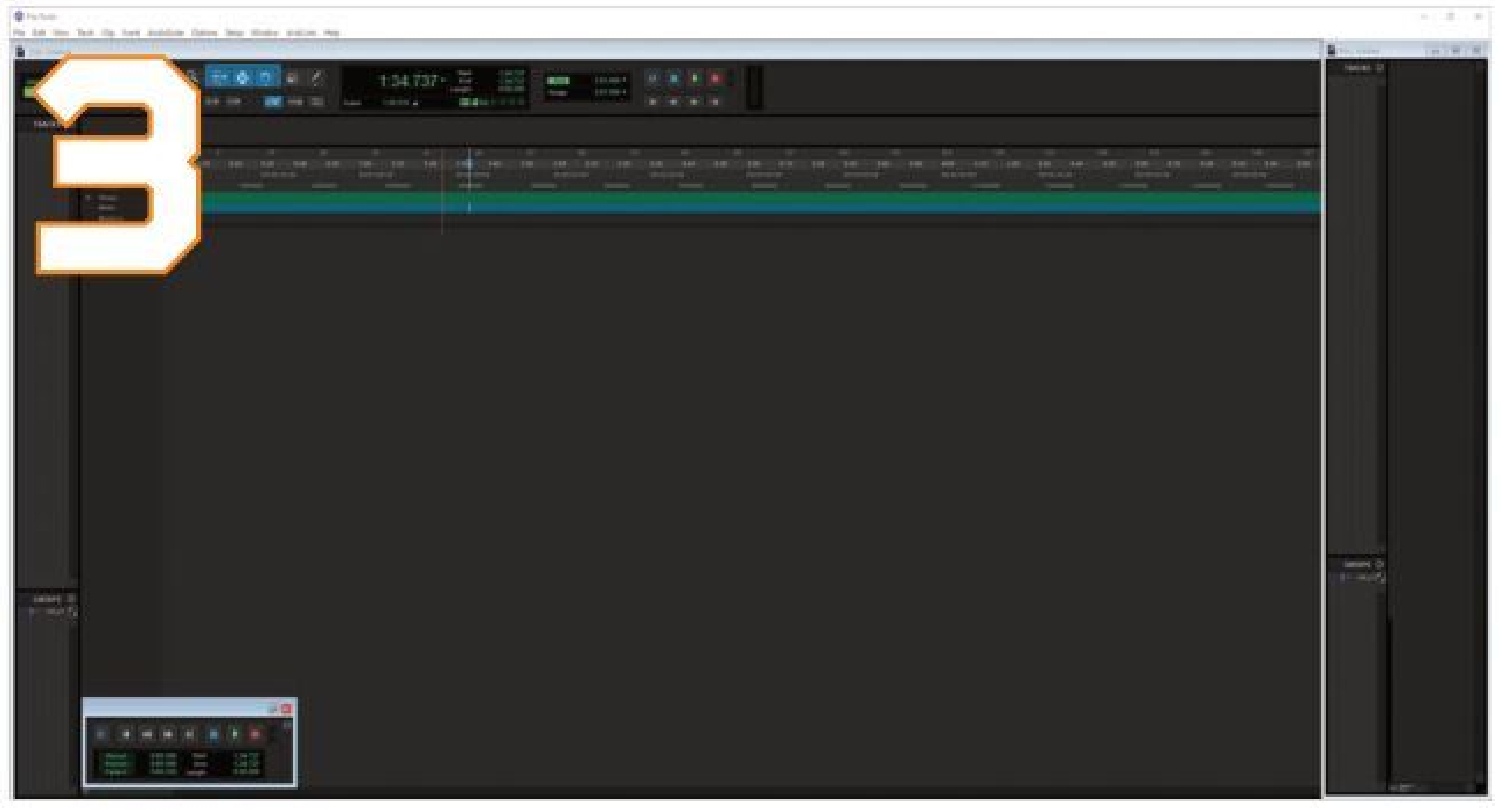
Music production no longer involves just a guitar and a microphone. These days it is often carried out on a PC with the aid of a digital audio workstation (DAW). This allows the user to mix, tune, stitch and compile recordings together to produce a final, polished piece of music, whether that's music, sound effects, or game sounds. Like all programs, there are many variants of DAWs available, each with their own pros and cons. Here, we list our top five favorites.



ACOUSTICA MIXCRAFT 9 **www.acoustica.com**
Apple fans rave about how easy *Garage Band* is to use – it's a fun application that can be used in both a casual and professional way. But what about Windows users? That's where Acoustica Mixcraft 9 comes in. It's ideal for beginners, yet it's not a basic program. Configured in a more traditional approach, it has a huge plug-in library, a great mixer, and a methodical workflow.
Mixcraft 9 Recording Studio $99, Mixcraft 9 Pro Studio $199



AUDACITY **www.audacityteam.org**
We had to throw this free, open-source application into the mix when it came to top DAWs. Yes, it looks pretty outdated and we wouldn't necessarily recommend it for professional or commercial use, but the best thing about it is that it's available to download for free. It's also pretty easy to get to grips with and if you want something to play around with, mix recordings together, splice them up or change formats, then Audacity is worth installing on your PC. ***$Free***



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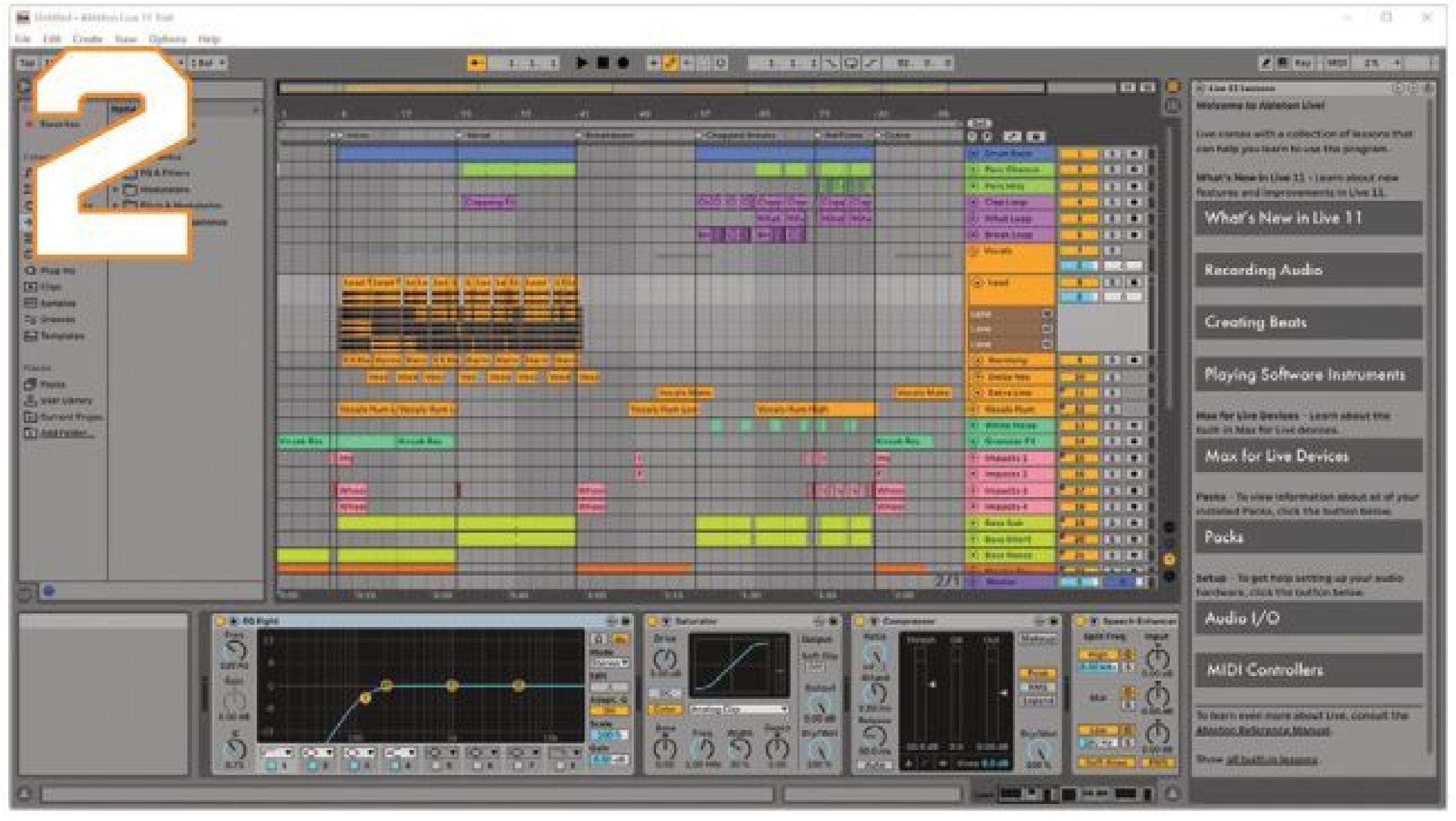
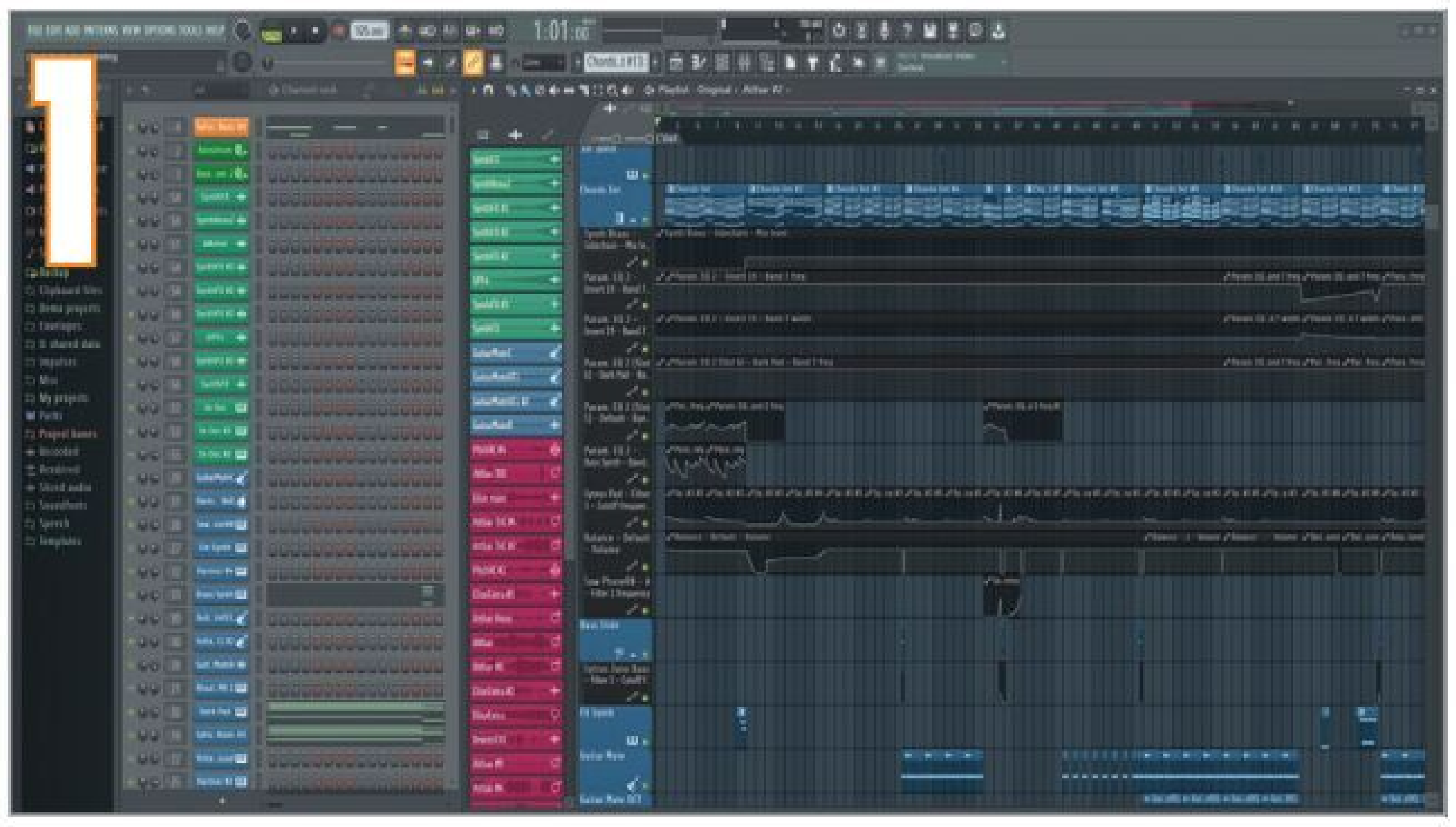
For recording engineers, mixers, musicians, and producers, Avid Technology's Pro Tools is one of the best DAWs. With its mastering capabilities second to none, it is ideal for large studio environments.
Pro Tools $399 (annual), Pro Tools Ultimate $800 (annual)



ABLETON LIVE **www.ableton.com**
With a quick and efficient workspace and a full suite of features, Ableton Live is a great program for producers. Launched in 2001, this DAW is not just a recording program, but an instrument in its own right.
Live 11 Intro $99, Live 11 Standard $449, Live 11 Suite $749



FL STUDIO **www.image-line.com**
FL Studio has been around for 20 years, and many top producers and DJs started here. Still one of the best, it looks fantastic and has lots of presets and effects.
FL Studio Fruity Edition $99, Producer Edition $199, Signature Bundle $299, All Plugins Edition $499

© ACOUSTICA, AUDACITYTEAM, AVID, ABLETON, IMAGE-LINE

Jeremy Laird

TRADE CHAT

Unbelievable bork

ASUS'S LATEST HIGH-SPEC TABLET PC hit my desk recently. Apart from its snazzy box, the most striking thing about the Vivobook 13 Slate OLED was a painfully obvious flaw. And that got me pondering how a fundamentally borked product makes it through the planning process and into customers' hands. You'd think obvious flaws or configuration errors would be filtered out, these days. But that Asus tablet, well, let's just say it has friends.

We'll come back to the Vivobook, but first I need to clarify the kind of fatal product flaws we're dealing with. I'm not talking about unintentional errors and strategic missteps baked in years before a product hits the shelves. Obvious examples involve certain integrated circuits. Most agree AMD's Bulldozer CPU architecture was a train wreck, but during the concept and design phase, it made sense.

When Bulldozer finally arrived, years after it was originally conceived, the software environment turned out not to be a great fit for the chip's strengths. You can argue AMD should have done a better job. But, when you're planning years in advance, it's easy to see how things can go wrong.

Something similar applies to Intel's more recent woes. Relative failures such as the Rocket Lake CPUs were a product of problems with Intel's manufacturing division, forcing the chip architects to cobble together yet another 14nm CPU using design elements originally intended for 10nm. The same applies to a product that was a good idea, but conceptually wrote checks that existing technology couldn't cash. I'm thinking, say, Apple Newton.

As it happens, I'm also not talking about products you could argue are intentionally crap. Some of the biggest PC brands crank out truly terrible desktop rigs full of proprietary parts, including motherboards and PSUs that limit your ability to maintain them out of warranty or add upgrades. Hideous stuff, but those PC builders want to cut costs or lock customers into pricey replacement parts. It doesn't happen by accident.

What this all boils down to, then, are screw-ups that, at least in the moment, were both avoidable and unintentional. The product wasn't meant to be bad and nor did it need to be. Which brings us back to that Asus tablet.

The clue to its core selling proposition is in the name. It packs an OLED display. Sure, it has pen input, a nifty detachable keyboard, fast charging, and all that good stuff. But so do a lot of other PC tablets. Few others, however, have a 13.3-inch OLED panel, the upside of which, according to Asus, is that this device doubles as a PC and an OLED TV. Yeah, that's the pitch.

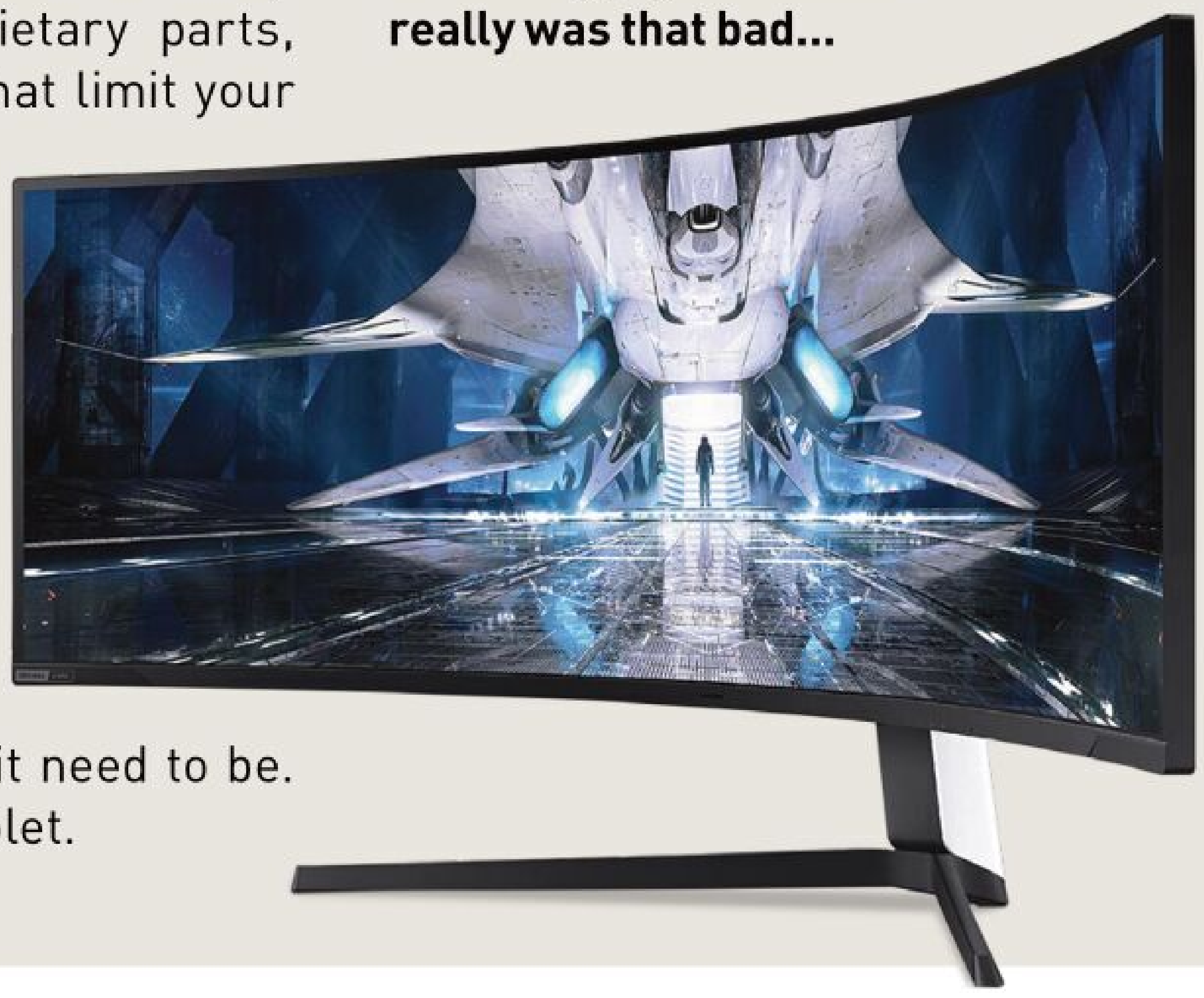
The problem is that the resolution is merely 1080p. The immediate consequence is a pixel density of 165dpi, which would be pretty good on a monitor and tolerable on a handheld device viewed at close quarters. But like many OLED panels, the Samsung-made item in the Vivobook doesn't have conventional RGB pixels. So, the sharpness and clarity aren't even as good as you'd expect from 1080p in a 13.3-inch device. The image quality is disappointingly fuzzy and chunky, which defeats the object of selling the device based on its OLED screen tech.

One of the worst execution errors in the last 12 months also involved some Samsung screen tech. The Neo G9 mega-monitor promised so much thanks to an upgrade to mini-LED technology. But when I first spooled the G9 up, I couldn't quite believe what I was seeing. The G9 has some seriously skanky stuff going on when it comes to the algorithms controlling the mini-LED backlight.

As a journalist, you question yourself in that situation. Could Samsung really put something that busted out the door, especially for around $2,000? The answer to that turned out to be yes, followed by an eventual firmware update.

In hindsight, I was soft on the Neo G9 in my reviews, probably scoring the thing too high overall. But it served as a reminder that even the big boys screw things up badly. With that in mind, why not drop us a line with your own picks for the biggest tech failures, both ancient and modern. If we get enough responses, we might put together a greatest hits compilation for your pleasure.

Samsung $2,000 Neo G9 really was that bad...



© SAMSUNG

Six raw 4K panels for breakfast, laced with extract of x86… Jeremy Laird eats and breathes PC technology.

DOCTOR

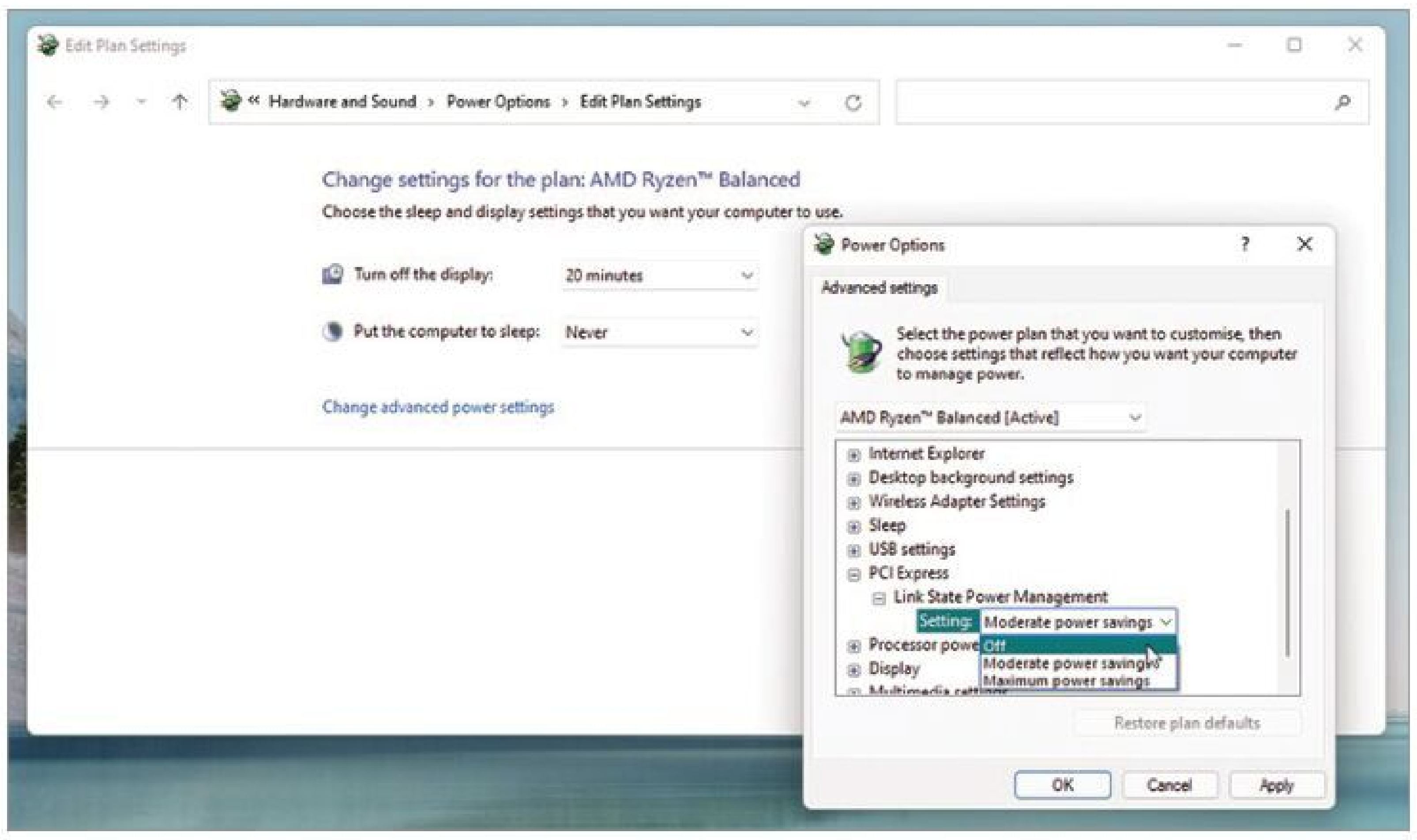
THIS MONTH THE DOCTOR TACKLES...

> USB drive disaster
> PC overwhelmed
> Old password tool

PCIe 4.0 glitch

I've been building PCs since the first 386 I put together, so I'm no stranger to PC problems. I recently bought a new computer from CyberPowerPC rather than build my own, thanks to the video card situation. I had three Seagate external drives connected to my old computer—two 3.5-inch drives with their own PSUs, and a USB-powered Backup Plus Portable. I connected all three to the USB ports directly on my MSI MPG X570 Gaming Plus motherboard. I had no problems with the two larger drives, but the portable drive kept disconnecting every few minutes. In Event Viewer, the System logs were filled with errors for that drive.

I didn't think the drive could go bad just plugging it into a new computer, so I updated the motherboard BIOS and all the drivers. Nothing helped. I chatted online with Seagate support and CyberPowerPC. They both had the usual suggestions—try a different cable, plug it into a different USB port, none of which worked. I submitted an RMA to replace the drive and while waiting for the new drive to arrive, I plugged it into the front USB port, which connects to the JUSB4 header on the motherboard. Astonishingly, the drive didn't experience any more problems (I still don't know why this port worked).


Edit Plan Settings
« Hardware and Sound > Power Options > Edit Plan Settings

Change settings for the plan: AMD Ryzen™ Balanced

Choose the sleep and display settings that you want your computer to use.

Turn off the display: 20 minutes

Put the computer to sleep: Never

Change advanced power settings
Power Options
Advanced settings

Select the power plan that you want to customise, then choose settings that reflect how you want your computer to manage power.

AMD Ryzen™ Balanced [Active]

Internet Explorer
Desktop background settings
Wireless Adapter Settings
Sleep
USB settings
PCI Express
Link State Power Management

Setting: Moderate power savings

Try disabling PCIe power-saving to resolve PCIe 4.0 glitches.

I searched the internet for any problems related to my motherboard and, to my surprise, I found out that AMD has a USB connectivity problem with its X570 chipset. When it is set to use PCIe 4.0, that appears to affect all motherboards using this chipset, not just my MSI. This problem has existed for around a year from what I've seen and there's still no fix. I have a Ryzen 5700G, which only supports PCIe 3.0, so I just changed the BIOS setting to use PCIe 3.0 and I've had no further problems. But that's not a permanent fix if I ever want to upgrade the CPU or my M.2 drive. I'm wondering how this problem has existed for so long, but yet the support people I chatted with had no knowledge of it and AMD doesn't have a fix.

—Kevin Mahoney

THE DOCTOR RESPONDS: First, thanks for sharing your detailed troubleshooting process and subsequent discovery. AMD acknowledged the problem back in February and released an AGESA firmware update (1.2.0.2) for Ryzen 5000-series CPUs that allegedly fixed the problem—but not for all. Interestingly, subsequent updates have been rolled out, your X570 board had two subsequent patches (1.2.0.3b and 1.2.0.3c) via BIOS updates but, in your case, clearly to no effect.

The Doc can't provide a definitive explanation as to why the front-mounted port proved more stable for your external self-powered USB drive. The front-mounted ports connect through the X570 chipset rather than directly to the AMD CPU (its four dedicated ports are on the back of your mobo), so would be subject to the same problems with PCIe, given that the X570 chipset interfaces with the AMD CPU through a PCIe uplink/downlink.

That said, some confirm the issue specifically manifests itself with USB 2.0 ports, which might explain why shifting the drive to the JUSB4 port (USB 3.2 Gen1 according to your mobo specs) got it to behave properly, but that assumes you hadn't tried rear-mounted USB 3.2 ports while troubleshooting.

However, the fact you've found a port you can use may mean you'll be able to upgrade your hardware and re-enable PCIe 4.0 at a later date, although you may then subsequently experience

↘ submit your questions to: doctor@maximumpc.com issues with other peripherals, specifically audio devices, connected via USB 2.0 ports.

Other workarounds reported by users that you could try include bumping the SoC voltage up and minimizing power saving for PCIe. Type 'power plan' into the Search box and click 'Edit a power plan'. Click 'Change advanced power settings' and expand 'PCI Express → Link State Power Management' and change the setting to 'Off' to see what effect that has.

One final suggestion is to open Device Manager after updating the BIOS and drivers, navigate to the Universal Serial Bus controllers section, then remove all USB controllers and hubs before rebooting to allow them to add themselves back automatically.

100% CPU usage

I've been following the magazine for a couple of years now, and have started to try my hand at buying used PC parts, building a system, and flipping it for profit. I recently built a modest gaming system with an AMD A10 9700 and a GTX 960 2GB (which I found for a great deal considering today's GPU prices) along with 8GB of DDR4, but I've encountered an issue with the CPU reaching consistent 100% usage in games and even just on the desktop for some reason.

Obviously, this is an older system, but I have a nagging feeling there's more to it. I suspect issues with the AMD chipset driver or Windows power settings, but what are your thoughts?

—Gavin Jones

THE DOCTOR RESPONDS: We suspect the key issue here is your hardware spec: the A10 is six-year-old tech that has been massively outclassed by today's CPUs. Indeed, it's currently comparable to the Pentium Silver J5040, a fanless, SoC designed for low-powered servers. With that in mind, it's going to struggle with the increased demands placed on today's ultra-fast processors by both Windows and applications alike.

Hardware upgrades that will help alleviate these problems include more RAM (aim for a minimum of 16GB for multi-tasking) and a fast SSD boot drive. That said, it's worth seeing if you can identify specific processes or applications that may be taking more than their fair share of system resources to exacerbate the problem.

The next time it happens, open Task Manager, go to the Processes tab, and click the CPU column once to show the most intensive processes at the top of the screen. Focus your troubleshooting on whatever processes are taking up available CPU resources, for example, is the Windows Search Index constantly running in the background?

If you're unable to target a specific culprit, or you find it's a case of too many applications struggling to rein in their demands, you might have to look at a tool like Process Lasso (https://bitsum.com/), which is designed to balance heavy loads on underpowered machines by reining in processes making excessive demands.

The free version provides all the key balancing functionality you need, but upgrade to the Pro version and you'll be able to set up profiles and exercise fine-tuned control over specific processes.

Password manager

Hope I'm not being a pest, but I have another request. I've been using KeePass Password Safe v1.71 for more years than I can recall. It's a simple encrypted basic database of all my account passwords and usernames, along with their URL and a comment box for notes.

It still works fine for my needs, but only supports Internet Explorer. The problem is that lately when I click an account's URL, the URL opens in Internet Explorer and I often get a message that the site doesn't support IE and wants me to switch to a different browser.

I have been searching for a new password manager, but I can't find one that works similarly to KeePass. I want one that keeps everything on my local PC, not in the cloud. Free would be great, but I don't mind having to pay a one-time fee—monthly or yearly subscriptions are out of the question.

I know I'm being picky, but the only issue I have with KeePass is that it just supports IE. If my only options are to go to the cloud or pay for a subscription, I'll just keep this outdated KeePass and then switch browsers when necessary.

—Steve Vanetti

THE DOCTOR RESPONDS: It sounds like you're relying on the KeeForm plugin to allow you to open websites automatically from KeePass, and this only works with Internet Explorer.

Given that KeePass development has stalled of late, you might want to look at a KeePass-compatible fork such as KeePassXC (https://keepassxc.org). This boasts a more modern look and feel, and can import your current KeePass 1.x database and convert it into the 2.x format. It also comes with a range of free browser extensions that enable you to easily access your passwords from within your browser.

If you're looking to move completely away from KeePass, perhaps to a tool that can be used with your mobile devices as well as your PC, then check out Buttercup (https://buttercup.pw/). Again, your passwords are stored offline in a secure database, but you can also install browser extensions and mobile apps (iOS and Android) to gain access to your passwords on the go in the same way as a cloud-based solution such as Bitwarden.

Block Win11 update

What can I do to prevent Windows Update from upgrading to Windows 11? I recently bought a new laptop that will support Windows 11, but I don't want to do that upgrade until all the bugs are sorted out and resolved, and most of those missing Win10 features are added back in.

I found a Registry hack on How To Geek (www.howtogeek.com/765377/how-to-block-the-windows-11-update-from-installing-on-windows-10/) but am hoping for something that does not require going into the Registry.

I've turned off Secure Boot and disabled the TPM, but am skeptical about that working. The BIOS has an option to 'Hide' the TPM, but I am also skeptical about that. I have made an external image of the drive a couple of times, but it is too small to allow for frequent internal backups (once it is out of warranty, I will fix that).

—Dave Marshall

THE DOCTOR RESPONDS: However insistent its prompts may be, there's no way Windows 11 is going to force itself on you before you're ready to upgrade, Dave. Unless Microsoft breaks all known conventions, it can't switch the TPM on in your BIOS or enable Secure Boot without your say-so. If Microsoft has determined that your laptop isn't compatible—and it technically isn't without Secure Boot or the TPM enabled—then it shouldn't keep nagging you to update it. The only feature updates you should be seeing will be the latest Windows 10 (21H2) update, which obviously is safe to install at this point.

Dave confirmed that he wasn't being prompted to update having disabled Secure Boot—he plans to revisit Windows 11 next year, at which point, he will then need to re-enable the TPM and Secure Boot to receive Microsoft's invite to install it.

THE ALDER LAKE MACHINE

New-gen Intel CPU, DDR5, plus a hefty graphics card… are you as excited as we are?

WELL, FOLKS, the time has finally come to put Intel's latest and greatest Alder Lake chip, the Core i9-12900k, into a pretty impressive build. On the face of it, this isn't the craziest looking rig we have ever put together, but there is serious power lurking beneath the chassis.

With this build, we are hoping to showcase some of the latest introductions to the PC market. We bring in some tasty new DDR5 RAM, Intel's latest CPU offering, a hefty Geforce RTX 3080, and one of the latest Z690 boards to piece it all together. All this and more is going to make its home in one of the largest cases we have seen in quite a while—frankly, this makes an ITX build look like a Gameboy in comparison.

As we carried out our build at the end of 2021, it's a great time to showcase a few of these new introductions. Of course, the last quarter of 2021 brought us Windows 11, which will be the chosen OS for this machine. Combined with that funky new DDR5 and Intel's latest Core i9-12900k chip, it makes for cutting edge stuff.

While we are always excited to try the latest offerings, it's not all sunshine and lollipops. For a start, the cost of a new chip, memory, and GPU will certainly leave a gaping hole in your wallet. We know everyone wants the latest tech but is it worth investing at the start of a new generation of goodies, or is it better to wait a while for the prices to drop? This build might help you to decide. So, let's see what we can get out of this thing. **–SAM LEWIS**

ALDER LAKE INGREDIENTS

PART		RRP/STREET PRICE
CPU	Intel Core i9-12900K	$589/ $620
GPU	ASUS ROG Strix GeForce RTX 3080 10GB	$850/ $1,800
RAM	32GB (2x16GB) Corsair DDR5-5200	$315
Mobo	Asus ROG STRIX Z690-E Gaming WIFI ATX	$470
OS Storage	2TB WD_Black SN750 M.2 PCIe 4.0 SSD	$299
PSU	NZXT C850 80+Gold PSU	$119
Cooler	2TB WD_Black SN750 M.2 PCIe 4.0 SSD	$230
Case	Corsair 7000D AIRFLOW	$260
TOTAL		**$3,132 / $4,213**

PRICES CORRECT AT THE TIME OF PRINTING

BUILD IT PG.22

CPU

INTEL CORE I9-12900K

$589/$620

Branded as the world's best gaming CPU on launch, this is a bold new hybrid step for Intel's architecture. With 16 cores split equally, eight foreground performance cores, and eight background efficiency cores, it aims for the best of both worlds. The i9-12900K sits at the top of the Alder Lake family boasting a frequency of up to 5.2GHz with one-click overclocking. It's everything we could want in a showcase build. *intel.com*

INTEL® CORE™ i9
i9-12900K
SRL4H
V134J271 e4

MOTHERBOARD

ASUS ROG STRIX Z690-E GAMING WIFI ATX **$470**

Following the traditional ATX format, this board from ASUS is one of the best to pair with some DDR5 and Intel's strongest Alder Lake chip right now. With support for 12th-Gen Intel, PCIe 5.0, 5 M.2 heatsink slots, and great gaming connectivity, it should be a strong board to keep everything under control. ***asus.com***

BUILD IT PG.22

MEMORY

32GB (2X16GB) CORSAIR DDR5-5200

$315

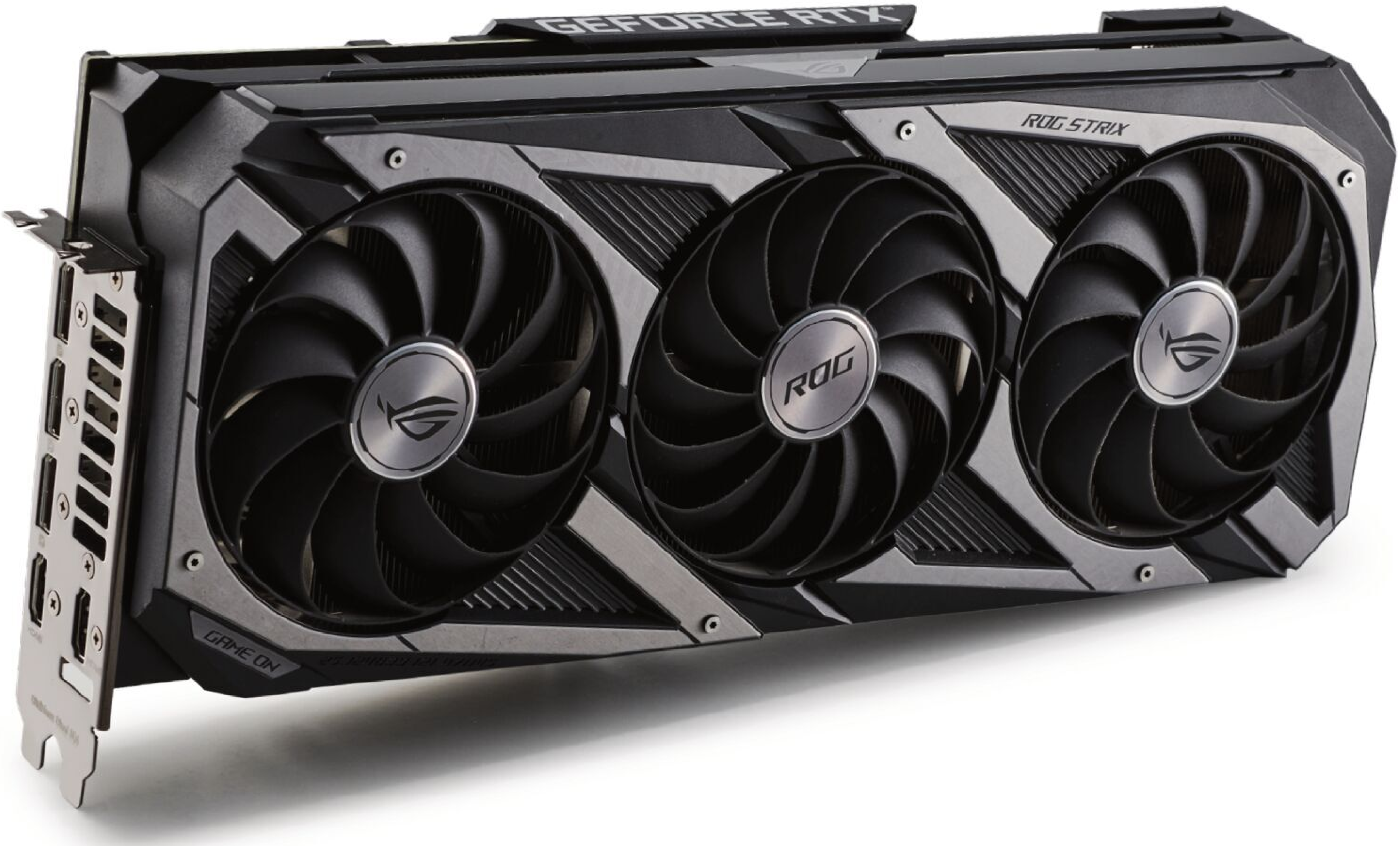
Yes people, give a big round of applause to Corsair's fresh new DDR5 RAM. Sure, it's hard to visually differentiate it from the previous DDR4 DIMM sticks, but it's the underpinnings and potential that push this generation of memory in a positive direction. With a speed of up to 5200MHz and a solid 2x 16GB configuration, this specific RAM makes a great addition to the build. *corsair.com*

VENGEANCE
VENGEANCE

GPU

ASUS ROG STRIX GEFORCE RTX 3080 10GB **$850/$1,800**

This is a pretty pricey GPU, but aren't they all these days? The sad reality is to get one of the best GPUs, you'll have to pay a pretty penny. With a markup of around $1000, it's hard to recommend these high-end GPUs at the moment, although the performance is exactly what you'd hope it would be. To get the most out of this rig, we needed a super strong GPU and ASUS's offering here is a great match for our build. ***Asus.com***

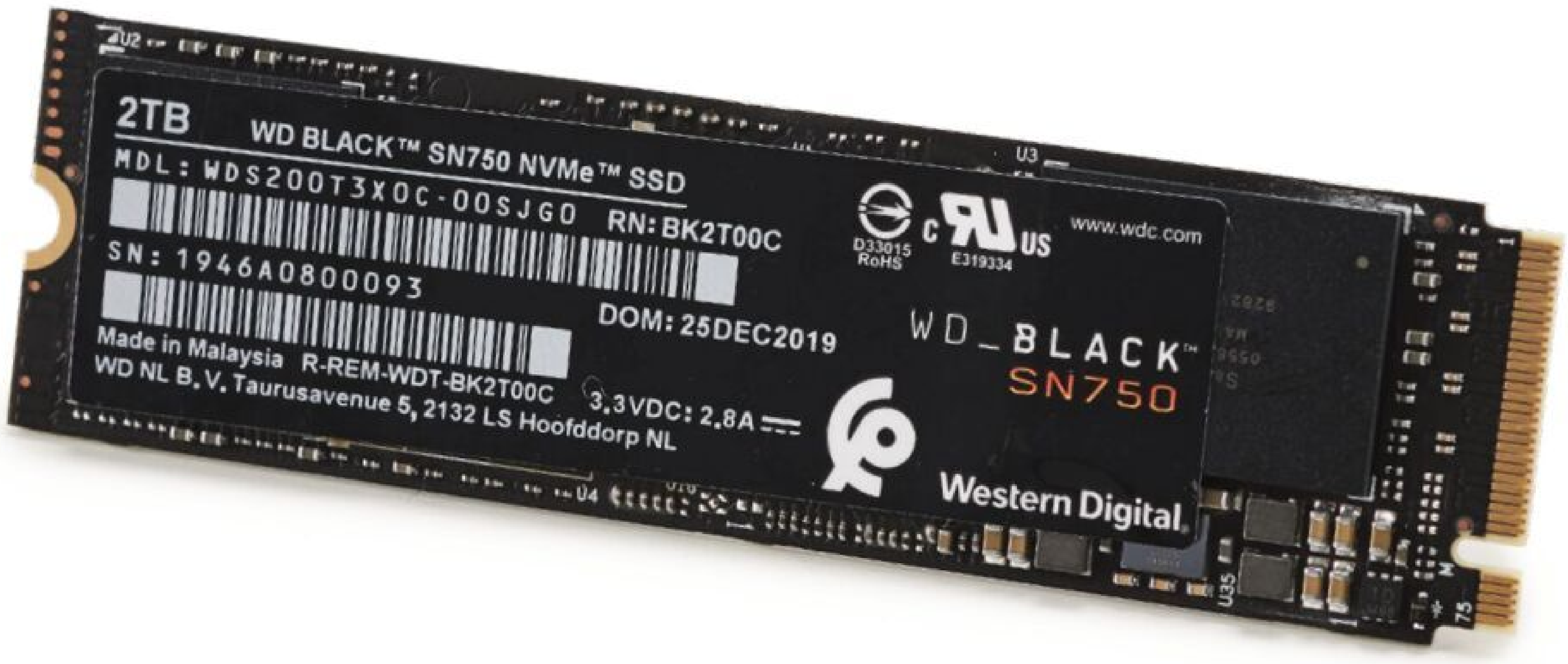


STORAGE

WD_BLACK SN750 M.2 PCIE 4.0 SSD

$299

When it comes to storage, Western Digital provides some of the best pieces of hardware around. 2TB of storage is plenty even though we don't have secondary storage in this build. Although it's not the latest SSD, it's still an incredibly dependable piece of storage with nippy speeds. We opted for the variant without heatsink as the Z690 board was providing that. *westerndigital.com*


2TB
WD BLACK™ SN750 NVMe™ SSD
MDL: WDS200T3X0C-00SJG0
RN: BK2T00C
SN: 1946A0800093
DOM: 25DEC2019
Made in Malaysia R-REM-WDT-BK2T00C
WD NL B.V. Taurusavenue 5, 2132 LS Hoofddorp NL
3.3VDC: 2.8A
www.wdc.com
WD_BLACK
SN750
Western Digital

CASE

CORSAIR 7000D AIRFLOW

$260

One word comes to mind when we take a look at this case, and that's behemoth. We wouldn't be surprised if you could enclose a whole other build (case included) inside this thing. Due to its large mass, it makes for great accessibility and loads of airflow, hence the name. The ability to mount seven 140mm fans here should keep this hot build nice and cool. Anyway, the construction is superb—if it didn't weigh so much, it would probably take off with those seven fans—and its sheer presence is begging for us to put something pretty special underneath. ***corsair.com***

BUILD IT PG.22

PSU

NZXT C850 80+GOLD PSU

$119

This machine is sure to use a decent amount of power, regardless of the fact that half of the new i9-12900k is made of efficiency cores. NZXT's PSU not only delivers 850W of power but also the peace of mind that you have covered the demands of this machine. With support for GPUs up to RTX 3090, it should be more than enough for our 3080. The modular design means we can use exactly what cables we need to keep things as tidy as possible. *nzxt.com*

NZXT
NZXT
C850

CPU COOLER

CORSAIR ICUE H170I ELITE CAPELLIX AIO ***$230***

To make the most out of this enormous case, we also need an equally huge AIO to keep things nice and cool. The iCUE H170i ELITE CAPELLIX from Corsair was a great match for our case and should do a solid job of keeping the internals nice and cool, especially the 12th-Gen Intel processor. It has three RGB fans to keep the front all sparkly and has a massive 420mm radiator. *corsair.com*

A NEW GENERATION

IT'S GOOD ON PAPER. BUT HOW WILL THIS 'NEW GEN' SYSTEM ACTUALLY PERFORM?

LENGTH OF TIME: **2-3 HOURS**

LEVEL OF DIFFICULTY: **MEDIUM**

1 CASE OPENING

HERE IT STANDS, all tall and proud. We've said it before, but this is one huge battleship. The 7000D AIRFLOW is an impressive feat from Corsair and feels as rugged as ever. Yes, it's pricey. But the build quality and size lends itself to this type of price tag. It features great accessibility with tidy cable management solutions around the back. There are also plenty of panels that pop off to allow for easier cable routing. We also love the wing-style side panel doors, reminiscent of a supercar. For a showcase build, we think it fits the profile nicely. First though, we pop open the wing-style panels and take off the front panel.

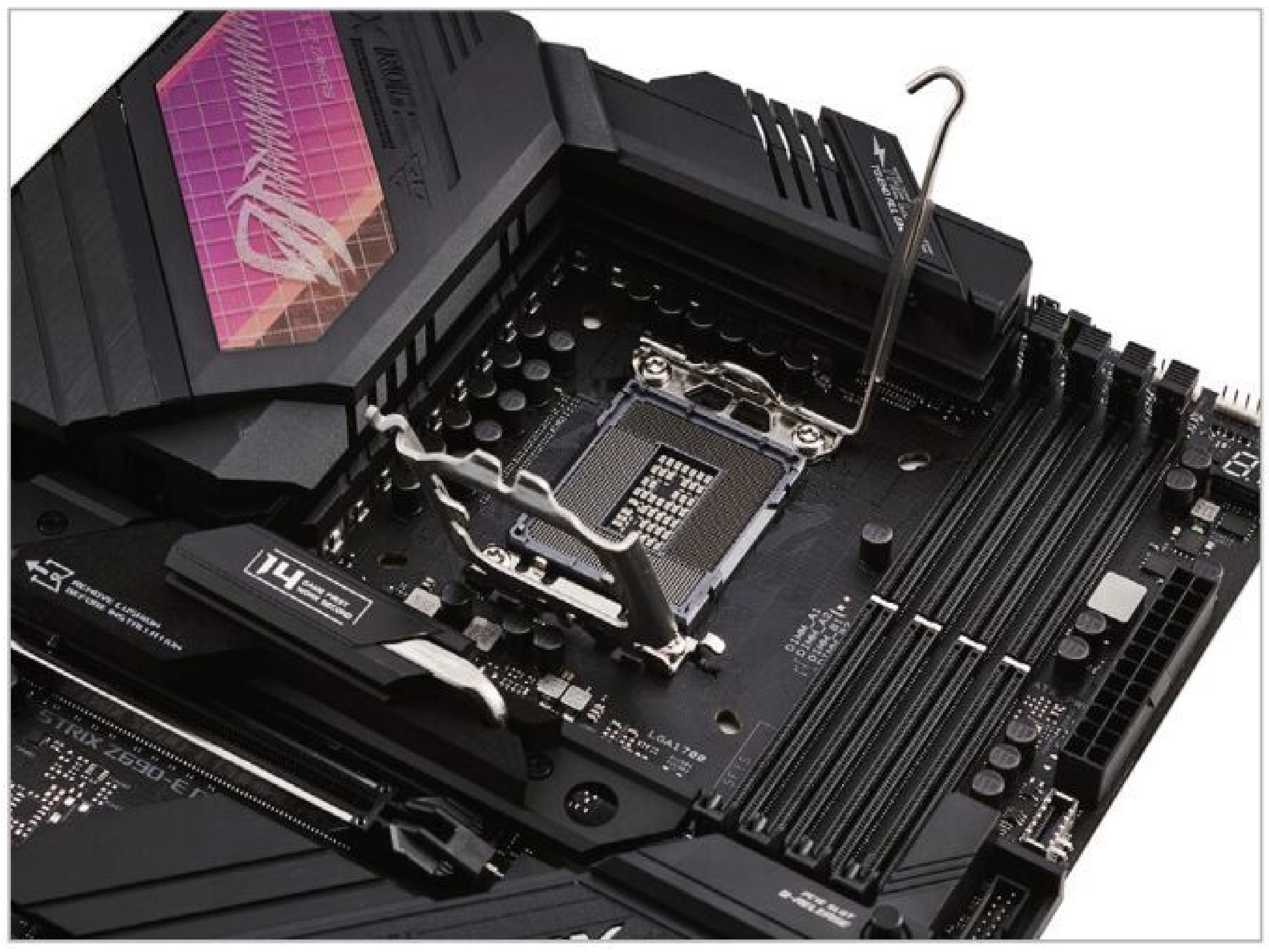
4 DDR5 TIME

JUST AS THE design hasn't changed all that much from DDR4 to DDR5, nor has the installation process, which is a good thing. Installing the DIMM sticks is one of the easiest parts of building a PC and gives us a little bit of time to relax in the build. Before installing, we always refer back to the motherboard's manual if we are using fewer than the full amount of possible DIMM slots. As we have only two sticks of DDR5 to use, we need to use the correct slots and this turns out to be slots 2 and 4. After identifying the correct slots, we push back the RAM tabs on the board and make sure the pins are aligned with the slots. Once happy, we push them in and they click nicely into place.

VENGEANCE
VENGEANCE

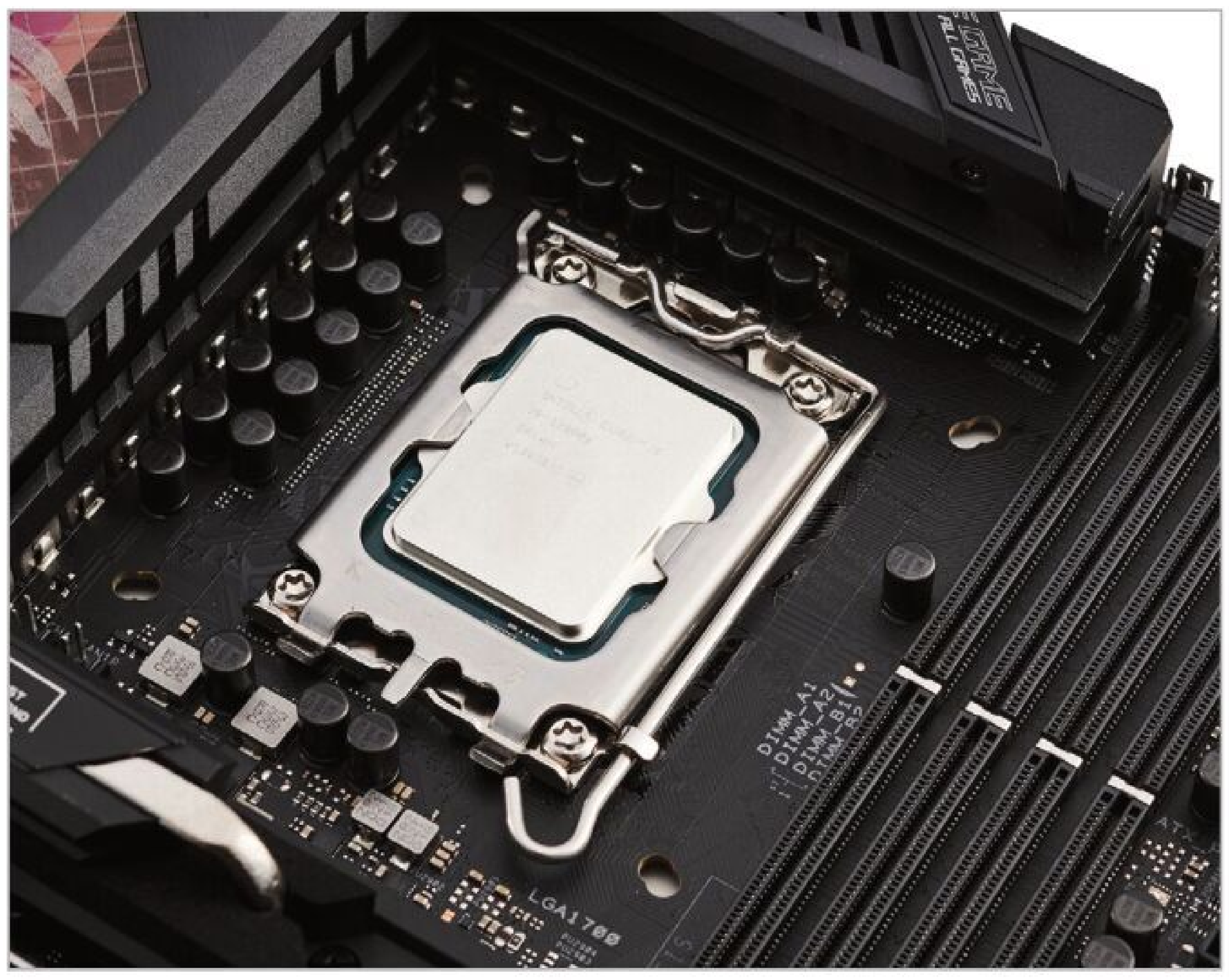
2 MOTHERBOARD PREP

BEFORE WE DIVE straight into this one and pop the motherboard into the case, we first need to prep it for the CPU. It's also much easier to attach all the necessary parts to the board before installing it. Yes, there is a lot of room around the board with this case but it's a good habit to work out the case first. Before we touch the CPU, we remove the plastic piece under the CPU latch. You don't actually need to do this, as it will pop out when you secure it down anyway, but it works either way round. To open the latch, lift the retention arm up slowly out of its catch. Push it down initially and to the right to release it. Easy-peasy.



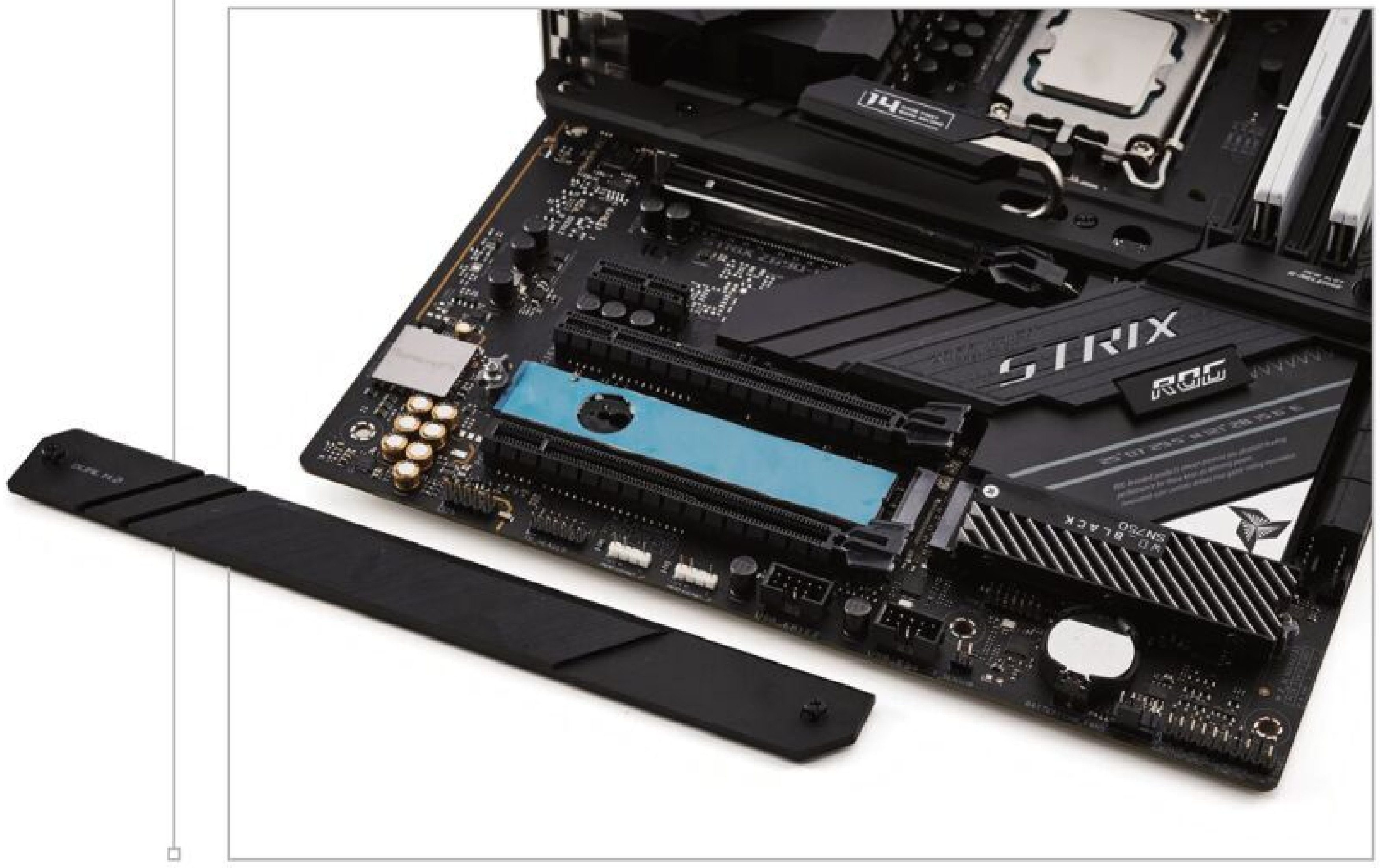
3 ALDER LAKE INSTALL

NOT ONLY DOES Intel's new processor bring a vast amount of architectural and generational changes but it also features a new socket, the LGA 1700, found on our Z690-E board from ASUS. Thankfully, this doesn't alter how we insert the CPU. Align the two triangles from the processor and the socket to make sure it's going in the right way. Then by grabbing the sides gently, rest it down into place, making sure not to touch any of the pins underneath. Once it is seated correctly, we pull the retention arm back down towards the latch and tuck it in to lock it in place.



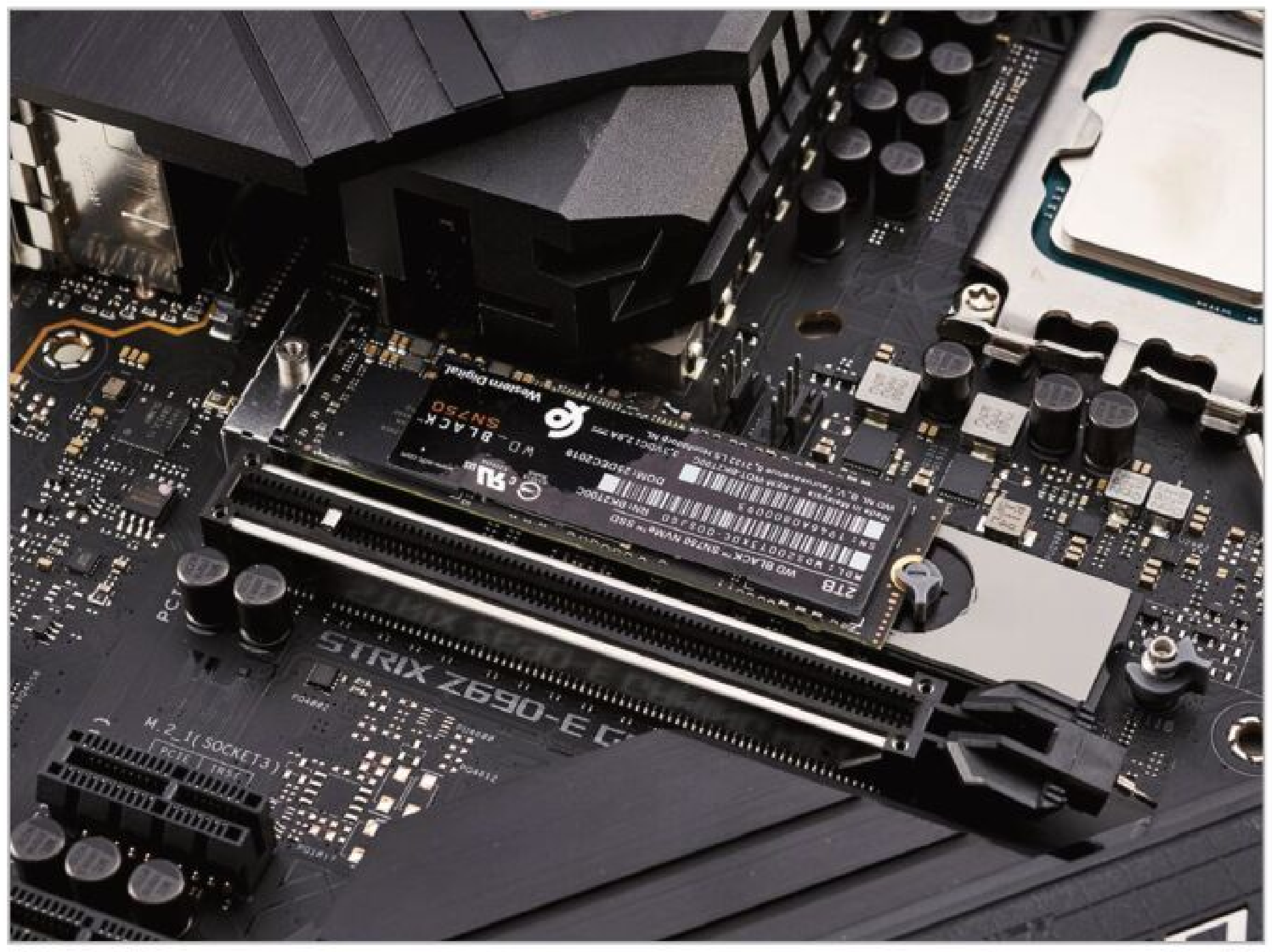
5 HEATSINK WOES

IF ONLY IT WAS as simple as just popping in the SSD. We love the way this board looks, so wanted to keep this look without removing any heatsinks. Unfortunately, we had to do this as our first SSD came with a heatsink itself. Note that we said 'first'—this SSD wouldn't fit with the motherboard's covers on top. Initially, we unscrewed the bottom SSD heatsink cover. This was one big long cover that has two slots underneath, one for a conventionally sized SSD, and the other could fit another and also a longer SSD. The problem is that if we use one side, the other side is exposed with the heatsink film, making the board look pretty ugly.



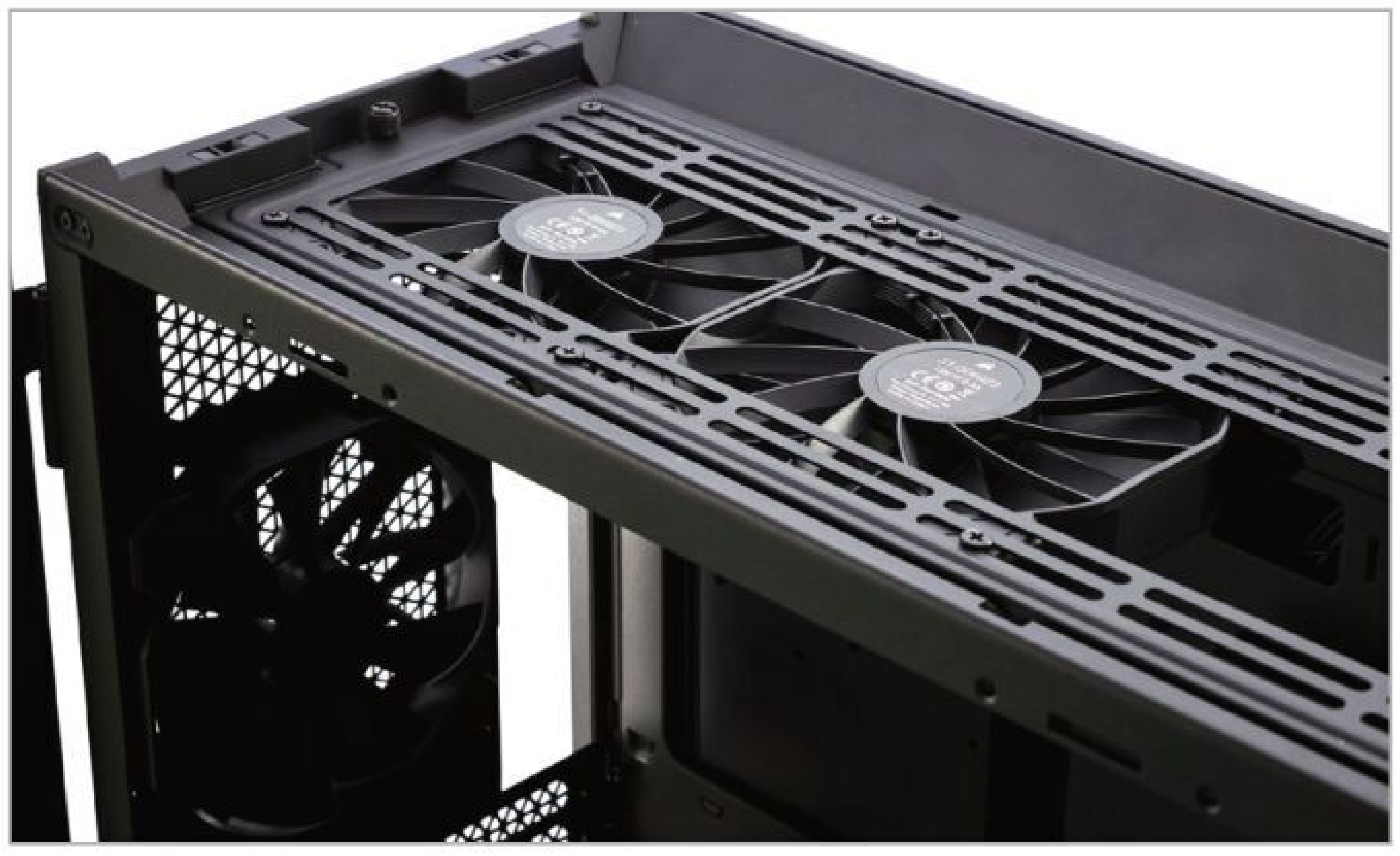
6 SSD SUCCESS

WE DIDN'T WANT to have an exposed empty M.2 slot, so we decided to use the top M.2 slot just under the CPU, which is technically a better slot. Again though, with the cover on top, this wouldn't fit over our WD_Black SSD due to its heatsink. Thankfully, the stars aligned perfectly as we happen to have the exact same SSD without a pre-installed heatsink lying around in our studio. We unscrew the top heatsink cover and slot in our SSD at a 30° angle to the port. Then, we secure it with the plastic screw covers that came with the board. After a few mishaps and then a little bit of luck on our part, the 2TB SSD from Western Digital was secured.



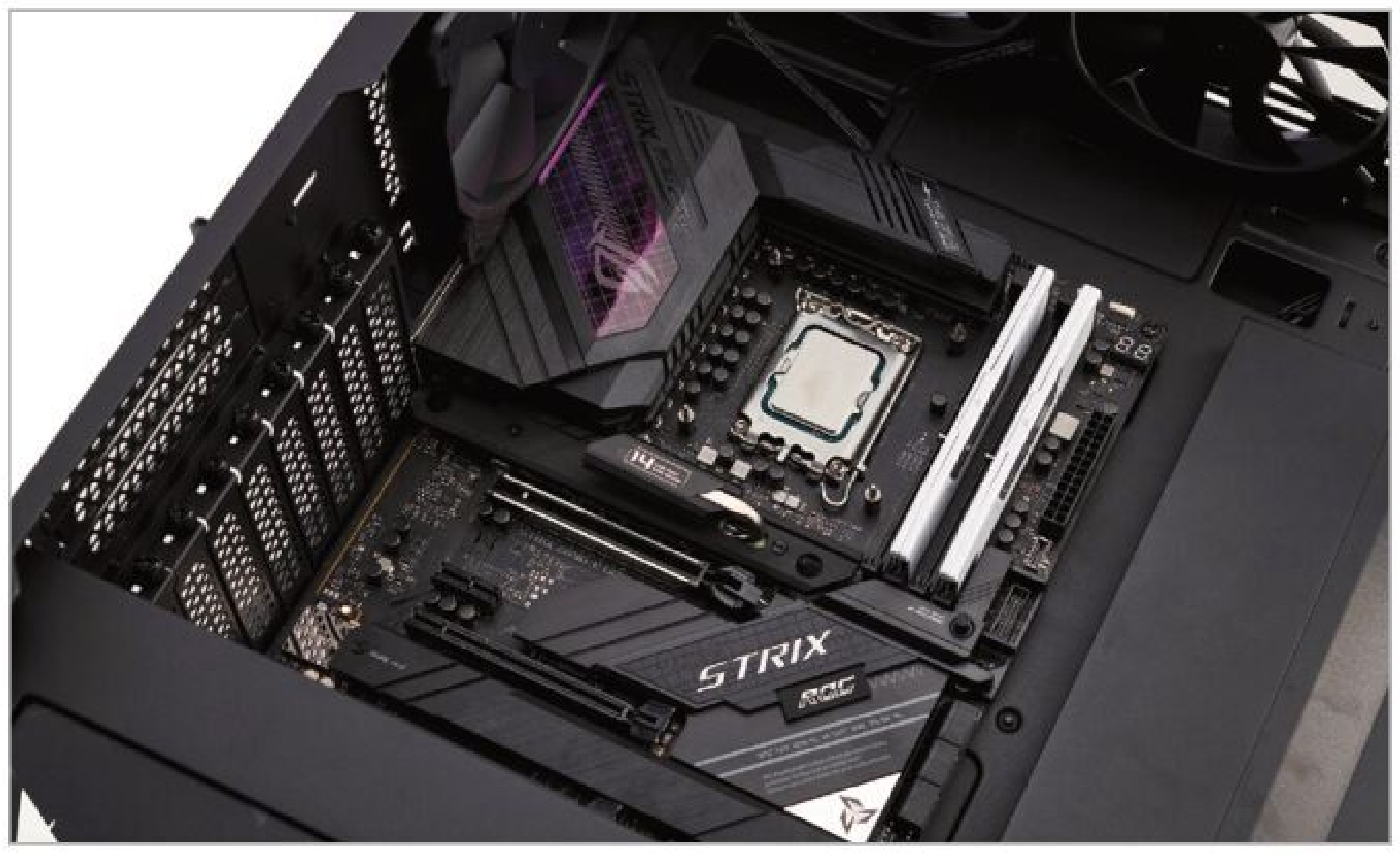
7 FAN RELOCATION

SO THAT WE COULD fit in our AIO later on with the Corsair RGB fans from that kit at the front of the case, we had to remove the front two fans. This leaves us with only one other place to put them, at the top. As all of our front three fans will be pulling in air through the case, and the other case fan at the back is already set up as an exhaust fan, we decided to use these as exhaust fans too. Remember, when it comes to fans, faces suck. This means we need to have the faces of the fans pointing towards the inside of the case in order to pull the hot air away from the motherboard. Each fan is connected with four Phillips screws and is super easy to detach and re-attach. Just make sure to route the cable through the back of the case and also ensure that it's long enough to reach the commander core fan controller.



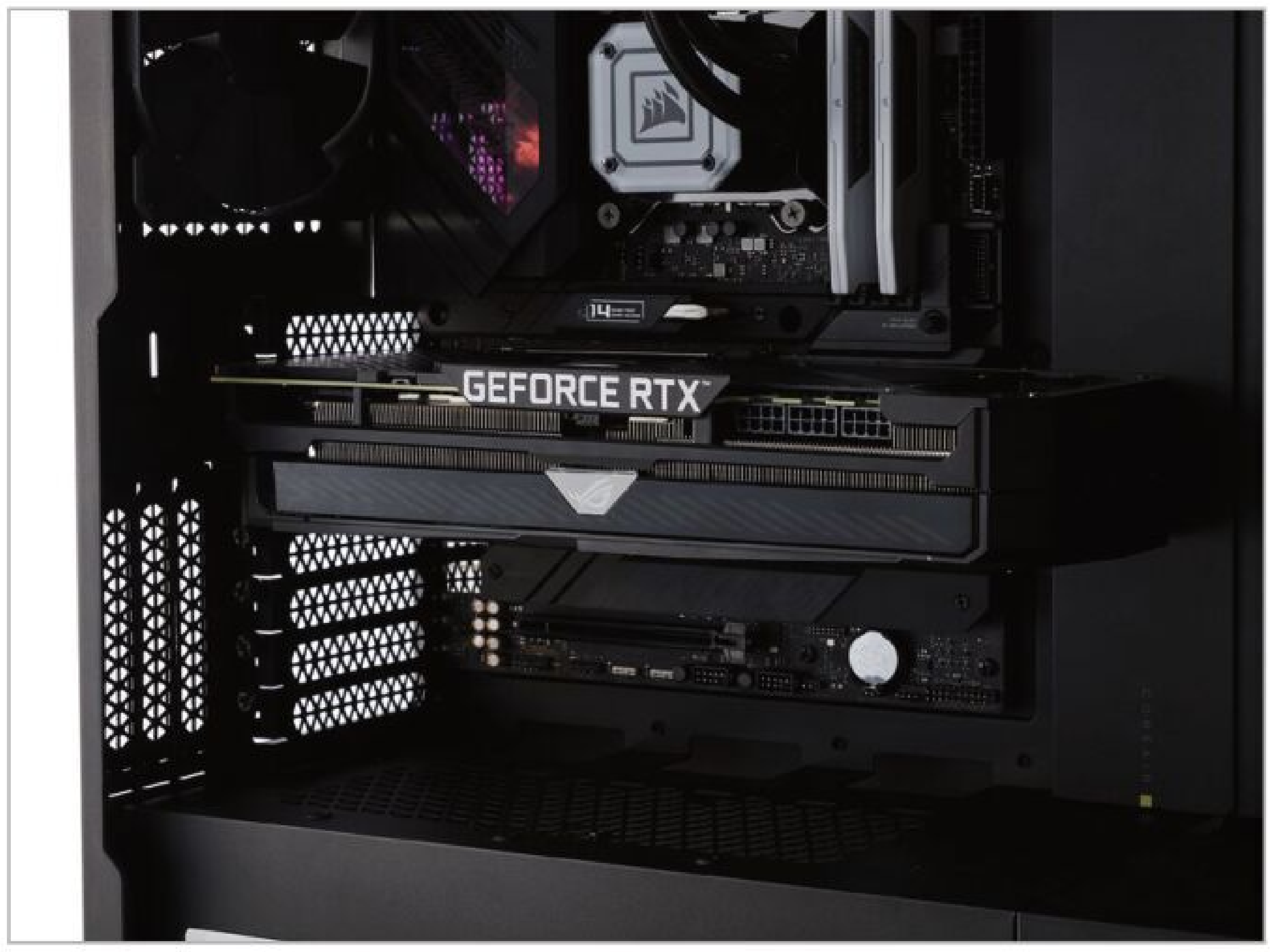
8 CPU COOLER BRACKET AND MOBO

BEFORE WE INSTALLED our motherboard into the case, we take both the winged panels off to lay the system down. After that, we attach the CPU cooler bracket for the AIO pump. This is an easy job, but make sure you choose the correct bracket, in our case the Intel one, and the correct standoffs. For this board and CPU, we use the Intel 115x/1200 standoffs. The bracket slots in behind the CPU at the back of the motherboard. Once aligned, screw the standoffs in place at the front of the board. Now it's time to install the mobo. It didn't need an I/O shield to be added first, so it's an easy installation. First, we angle the I/O plate into the slot in the case and gently rest it flat in place. Using eight screws, we fasten it onto the board, starting with the corners then the middle screws. And, just like that, the board is in.



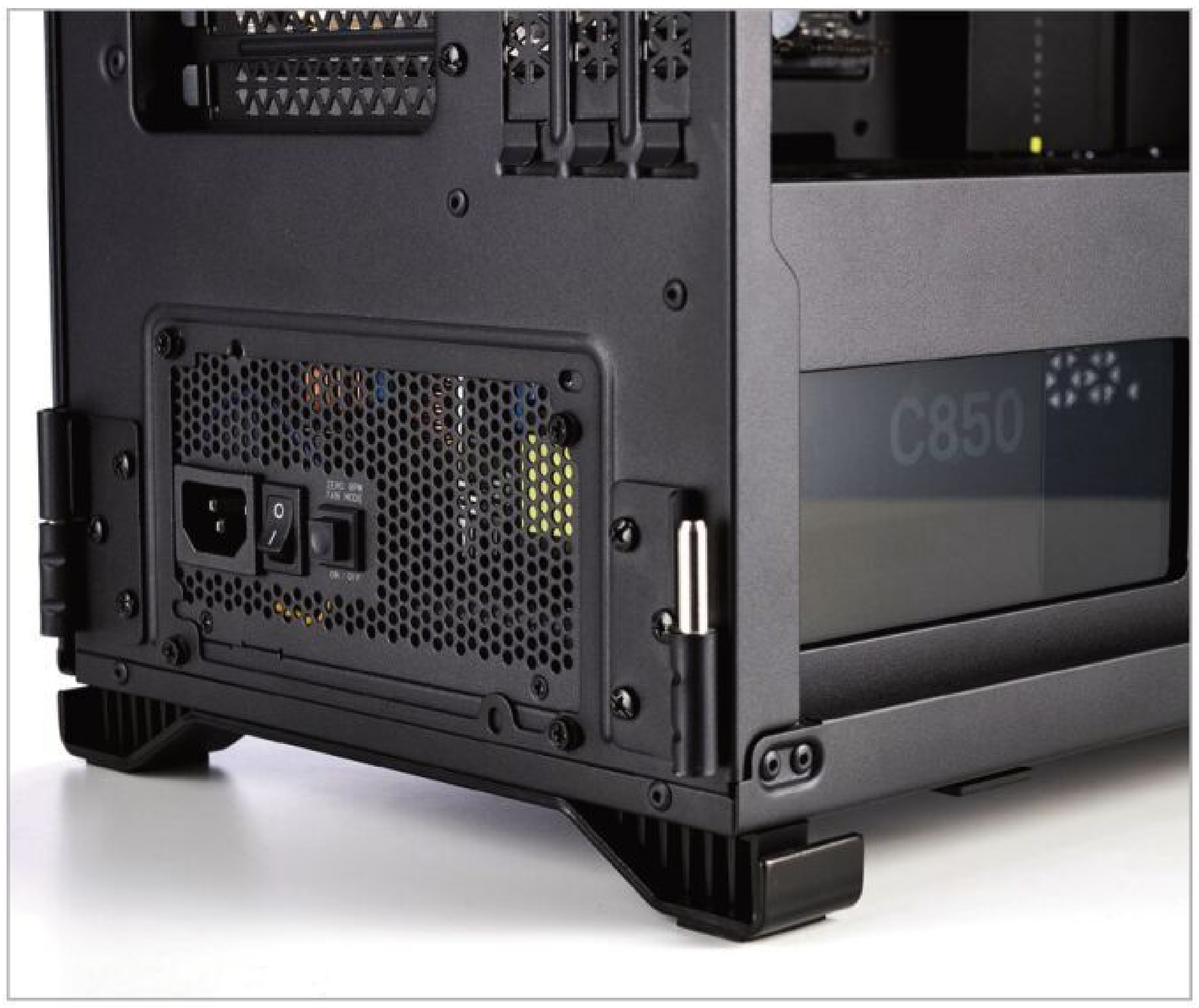
11 ADDING THE GPU

NOW, THIS IS ALWAYS a pretty nice addition to the build and by the size of this 3080 from ASUS, we are glad we chose this huge 7000D AIRFLOW case to fit it in. To add this into our case, we first have to take off two of the small backplates from the back of the case. We don't need to take the top one off just the two below it to make room for our GPU ports. Then we push down the PCIe tab which is similar to the tabs holding the RAM sticks in place. First, make sure the port section of the GPU goes in at an angle so it fits in with the case, then make sure it clips in place to the PCIe slot. We choose the top slot as this is the primary PCIe port.



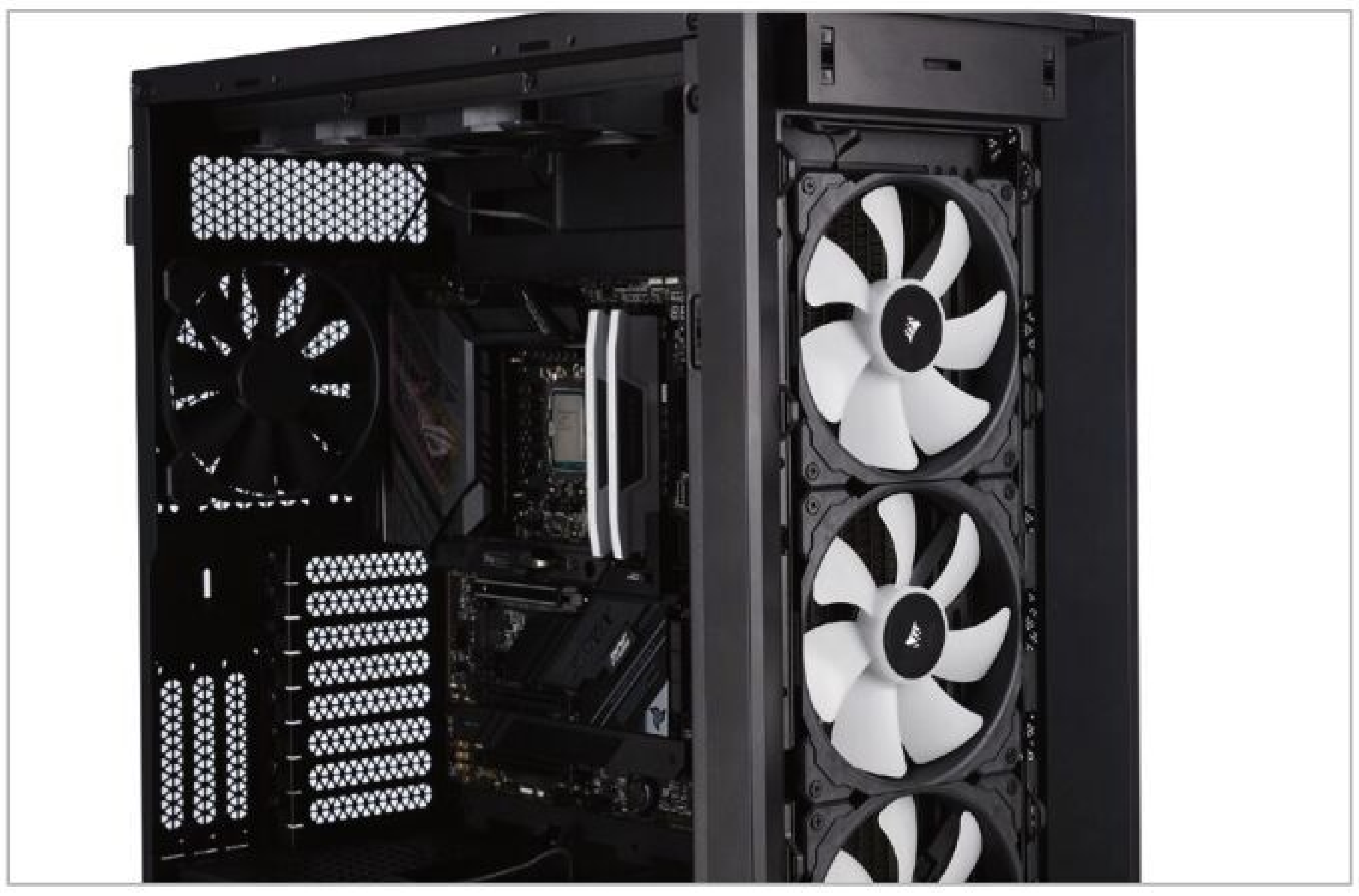
12 SUPPLYING THE POWER

THE LAST HARDWARE component to go in is our NZXT C850 PSU. This is a modular design, so we could easily install this with no cables getting in our way (yet). The PSU slots right in the bottom of our case and secures into place with four screws. This adds even more weight into the already hefty build, so we're glad we only had to pick this up and transport it once. Don't try lifting this build on your own, aside from the aches that will follow, you don't want any chance of dropping this monster, that doesn't even bear thinking about.



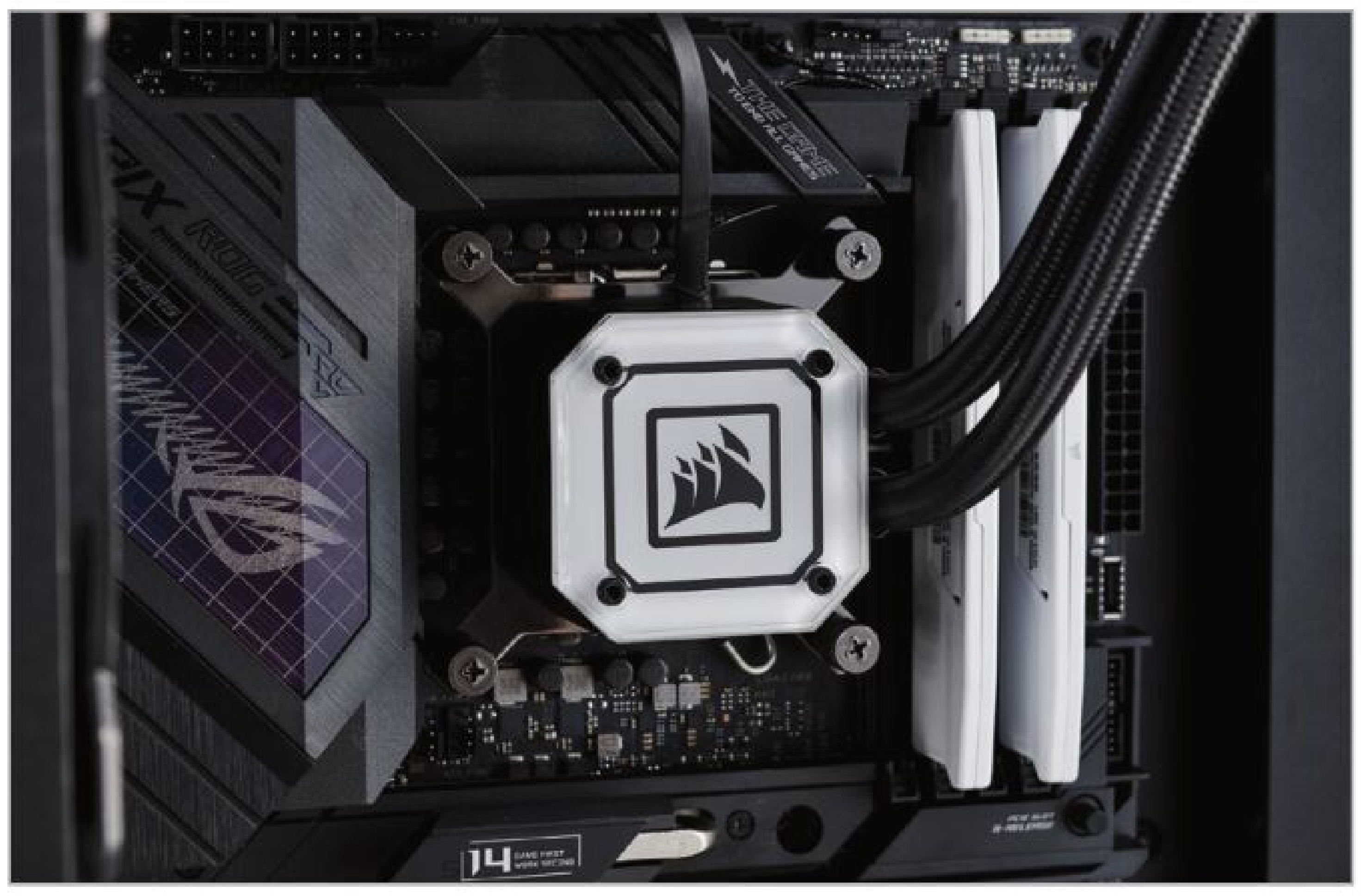
9 COOLING TIME

WITH THE CPU cooler bracket and mobo securely in place, it's time to install our radiator and fans. As we moved the stock case fans earlier, we could fit the three Corsair RGB fans at the front of the case that came with our H170i ELITE CAPELLIX AIO. Holding the radiator in place, we attach our first top fan making sure the fan cables feed to the back of the case. We also make sure that the radiator pipes come out of the topside of the radiator for better circulation. It can be fiddly to get the first few screws in place as they feed through the front of the fans, the frame on the case, and then into the radiator but, after this, everything should align nicely. To keep the airflow pulling in from the front, we have the faces facing outwards—as we mentioned earlier, 'faces suck'.



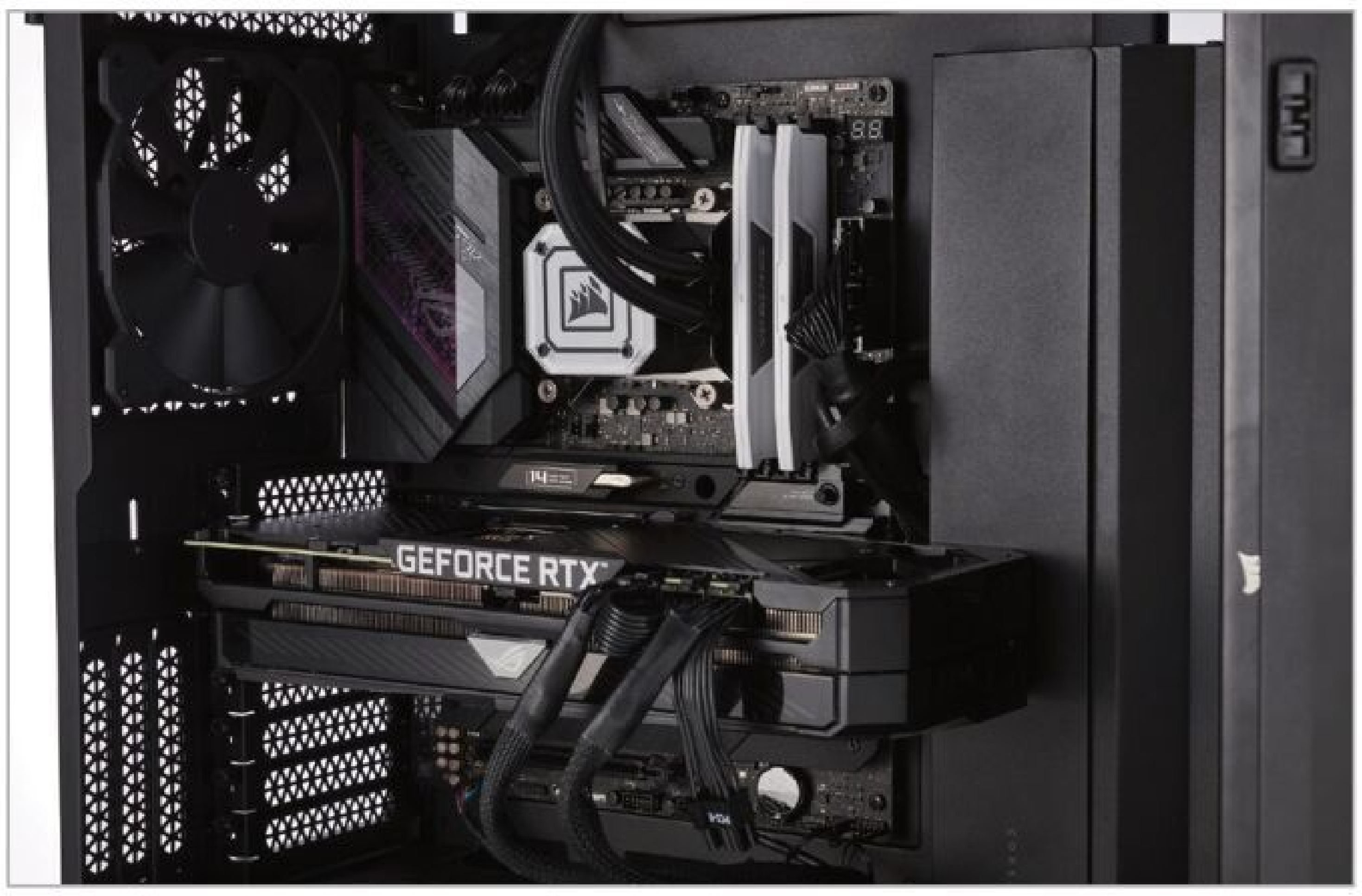
10 CPU HEADER

AFTER THE FANS and the radiator are sorted, it's time to add the rest of our AIO into the build, the CPU header. This also needs the correct Intel bracket on it to fit, which it already did, thankfully. The first thing to do though is to add a pea-sized drop of thermal paste onto the center of our Intel i9-12900K CPU. To fit properly, it has to be in the correct orientation with the radiator pipes coming out of the right-hand side. Once oriented and thermal paste applied, we carefully align the CPU header onto the CPU and secure it down with the supplied thumbscrews. Slightly tightening diagonally to get even pressure across the CPU. Once happy, we use a screwdriver to tighten some more, then connect the CPU fan cable straight to the motherboard.



13 CONNECTING THE DOTS

SO AT THIS POINT, we have every component in place but it's no good without connecting up the veins of the PC. Start by connecting up the front panel cables—check the motherboard's manual to locate where these go. This stage can be fiddly, but there is plenty of room in this case and it is a quicker process than normal. After this, we attach the PSU cables to the motherboard first, then route them through the back and to the PSU. This includes PCIe cables for the GPU, the 24-pin motherboard cable, two CPU cables, and one SATA. We connect the SATA to the commander core fan controller and then the fan and RGB cables up to the controller. Nothing was too much of a squeeze to fit in, just awkward and precise, but when isn't it?

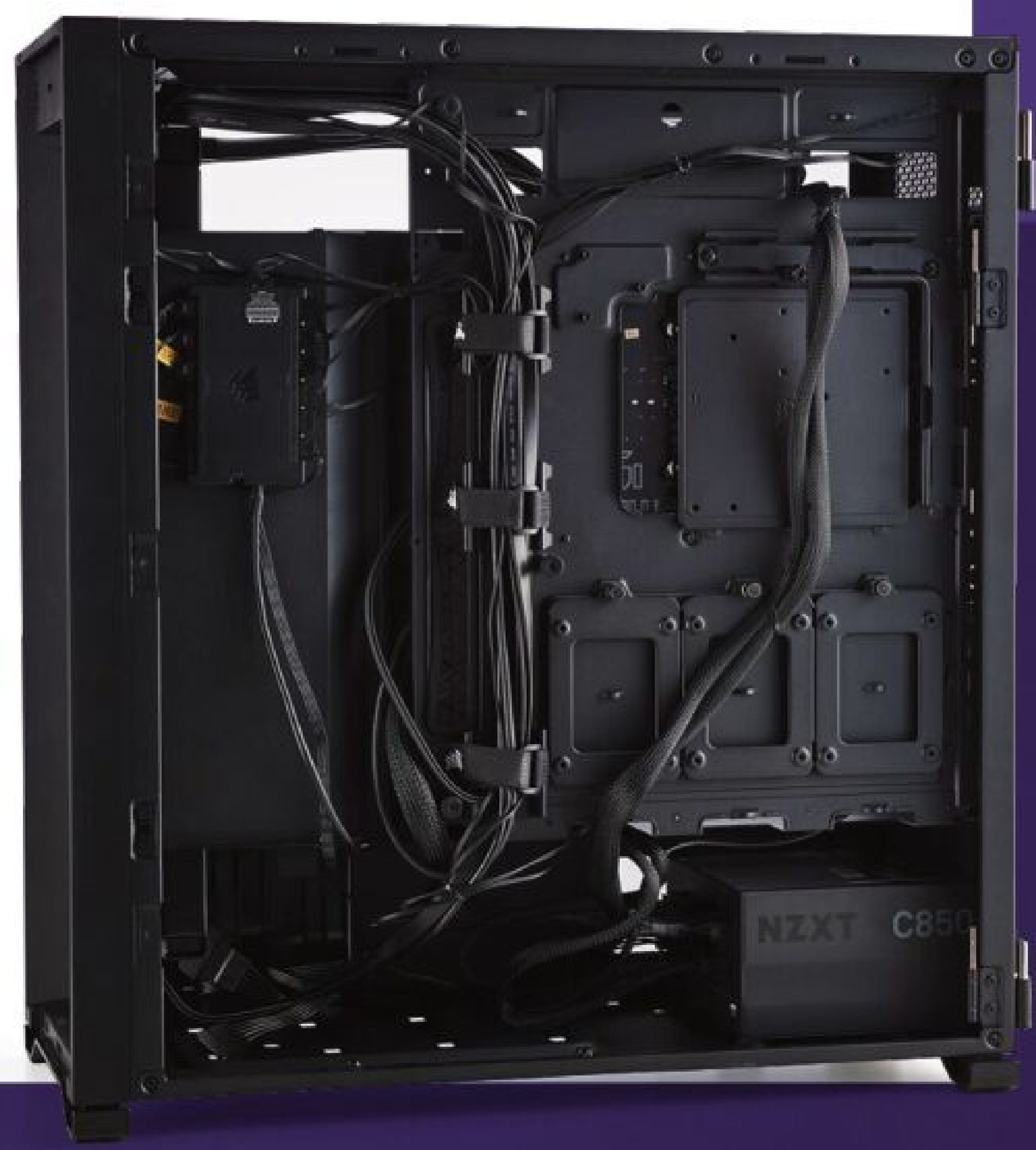


14 TIDYING UP

TECHNICALLY THAT'S IT for our build. It was pretty successful on the whole, hardware-wise anyway. Before we head over to the software side of things, we need to do a bit of cable management and get this PC paneled up. We don't often recommend cable managing to a permanent level until the end and until we know everything is powering on at least. So, we flick the switch, and thankfully, our build begins to spark into life.

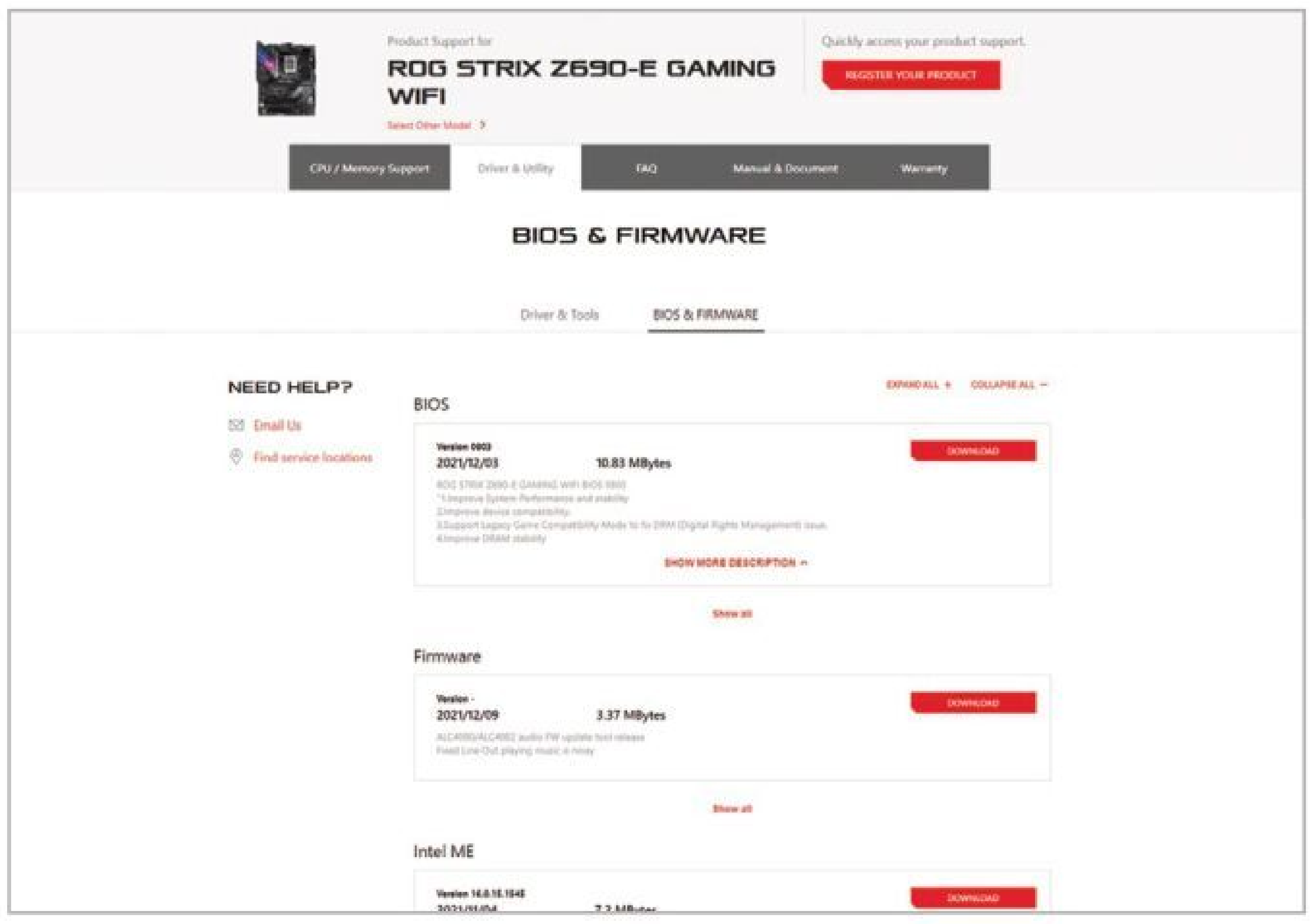
Throughout the build, we recommend keeping cable management in mind by routing cables to the best place possible. At this stage, we just need to tuck things out the way or use the cable ties. Thankfully, this case has some good cable management routing solutions, which we follow, and in areas where we create our own paths, we use the cable ties to neaten things up.

After this, we pop on the panels once again, give it a quick wipe to get rid of any fingerprints, and our PC is built.



15 PREPARING BIOS UPDATE

SO ONCE THE BUILD is complete, we hook this thing up to a monitor ready to boot it up. However, we need to update the BIOS first in order to move forward. For this method, we are using a USB drive and another system to perform the BIOS FLBK (flashback) method. We head over to the motherboard's support page and download the latest BIOS update to the USB drive. Make sure the drive is empty and formatted correctly to FAT32. The download will consist of a CAP file and a renamer tool. First, we extract the folder then run this tool afterward to rename the CAP file. Then we delete everything on the drive, apart from the newly renamed CAP file.


Product Support for
ROG STRIX Z690-E GAMING WIFI
Select Other Model
Quickly access your product support.
REGISTER YOUR PRODUCT
CPU / Memory Support
Driver & Utility
FAQ
Manual & Document
Warranty
Driver & Tools
BIOS & FIRMWARE
NEED HELP?
Email Us
Find service locations
EXPAND ALL +
COLLAPSE ALL −
DOWNLOAD
SHOW MORE DESCRIPTION
Show all

BIOS & FIRMWARE

BIOS

Version 0803
2021/12/03 10.83 MBytes

Firmware

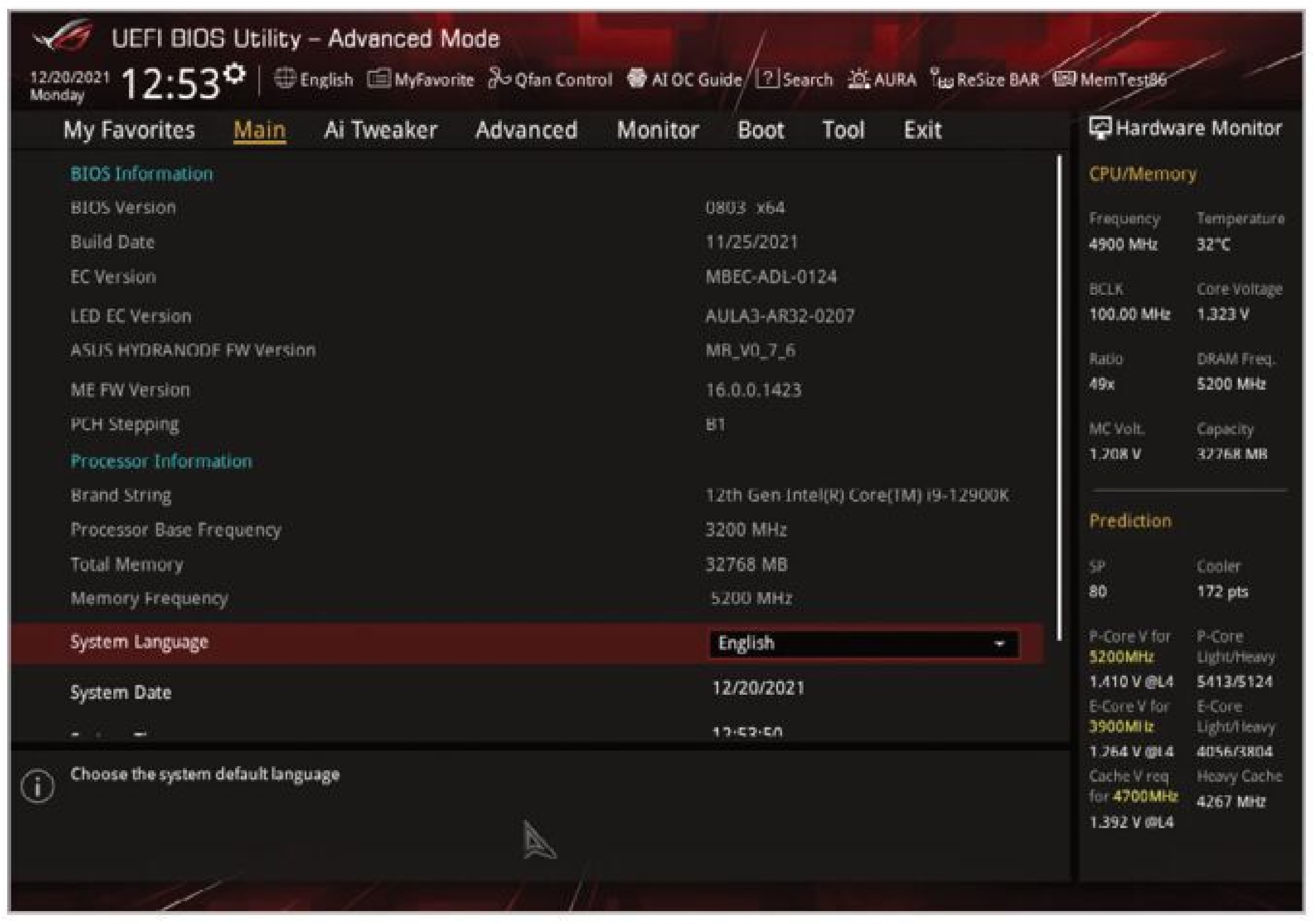
Version -
2021/12/09 3.37 MBytes

Intel ME

Version 16.0.15.1045

16 INSTALLING BIOS UPDATE

MAKE SURE that your new system is off but with power running to the machine and with the PSU switch turned on. Then insert your USB stick with the BIOS update into the port in the back of the PC labeled BIOS FLBK, this should have a button directly above it and a white line distinguishing it from the other USB ports. Then, hold down the BIOS button for at least three seconds or until you start seeing a green flashing light and let go. After around 10 seconds, this light should start flashing faster. It will continue until the BIOS has been updated, don't turn off the power in the meantime. Once the light has stopped, boot up your system and the BIOS should hopefully be updated. Now it's ready to install Windows 11.


UEFI BIOS Utility – Advanced Mode
12/20/2021
Monday
12:53
English
MyFavorite
Qfan Control
AI OC Guide
Search
AURA
ReSize BAR
MemTest86
My Favorites
Main
Ai Tweaker
Advanced
Monitor
Boot
Tool
Exit
Hardware Monitor

BIOS Information	
BIOS Version	0803 x64
Build Date	11/25/2021
EC Version	MBEC-ADL-0124
LED EC Version	AULA3-AR32-0207
ASUS HYDRANODE FW Version	MR_V0_7_6
ME FW Version	16.0.0.1423
PCH Stepping	B1
Processor Information	
Brand String	12th Gen Intel(R) Core(TM) i9-12900K
Processor Base Frequency	3200 MHz
Total Memory	32768 MB
Memory Frequency	5200 MHz
System Language	English
System Date	12/20/2021

Choose the system default language

CPU/Memory

Frequency 4900 MHz	Temperature 32°C
BCLK 100.00 MHz	Core Voltage 1.323 V
Ratio 49x	DRAM Freq. 5200 MHz
MC Volt. 1.208 V	Capacity 32768 MB

Prediction

SP 80	Cooler 172 pts
P-Core V for 5200MHz 1.410 V @L4	P-Core Light/Heavy 5413/5124
E-Core V for 3900MHz 1.264 V @L4	E-Core Light/Heavy 4056/3804
Cache V req for 4700MHz 1.392 V @L4	Heavy Cache 4267 MHz

NEXT GEN FUTUREPROOF?

SO HERE WE ARE, the machine's all built, everything fits together (eventually), and everything works (at last). Yes, we did have some teething issues. On first boot up, we couldn't get through the Windows 11 installation without it crashing. In fact, the error was to do with the CPU cooler and our CPU was briefly hitting around 88° under practically zero load.

That almost left us quaking in our boots, but thankfully it was a simple error. After a bit of cable management, we managed to dislodge the main commander core fan controller cable. Unfortunately, we didn't figure this out until we removed the CPU cooler and reinstalled it with some new thermal paste. Better safe than sorry.

Other than this issue and our little mishap with the heatsink SSD situation, it was fairly smooth sailing for our Alder Lake system build. The Corsair 7000D AIRFLOW case was easy to work in, mainly due to the sheer amount of space we had. Usually fitting the CPU cables from the PSU to the motherboard can be a pain in the rear end but, for once, it was a quick process with plenty of room to fit the bend of the cable in. The only issue was moving this rig around—when fully built, it's one hell of a heavy unit.

The performance of this machine was great and what we expected. Intel's Extreme Tuning Utility allowed our CPU to run from 4.90GHz to 5.10GHz all from some easy one-click tuning. With sliders cranked all the way to the right, this PC runs super nice and quiet. Thanks to the huge 420mm radiator, six 140mm fans, and plenty of space available in this case, temperatures are great even when this is under full load.

Of course, at an MSRP of just over $3000, it costs a pretty penny. At this price, you expect it to run the numbers it does on the benchmarking. But is it worth investing in now? Probably not. You're better off waiting a while for these prices to fall—with every generational change, they always start off sky-high. However, this is certainly a clean, future-proof build in a monstrous case that has tons of presence.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread (Index)	2,413	4,189 (74%)
CrystalDisk Q32T1 Sequential Read (MB/s)	2,721	3,344 (23%)
CrystalDisk Q32T1 Sequential Write (MB/s)	2,769	2,911 (5%)
Tom Clancy's Ghost Recon: Wildlands (fps)	62	69 (11%)
Total War: Warhammer II (fps)	75	98 (31%)
Rise of the Tomb Raider (fps)	103	78 (-24%)
3DMark: Fire Strike (Index)	26,706	37,817 (42%)

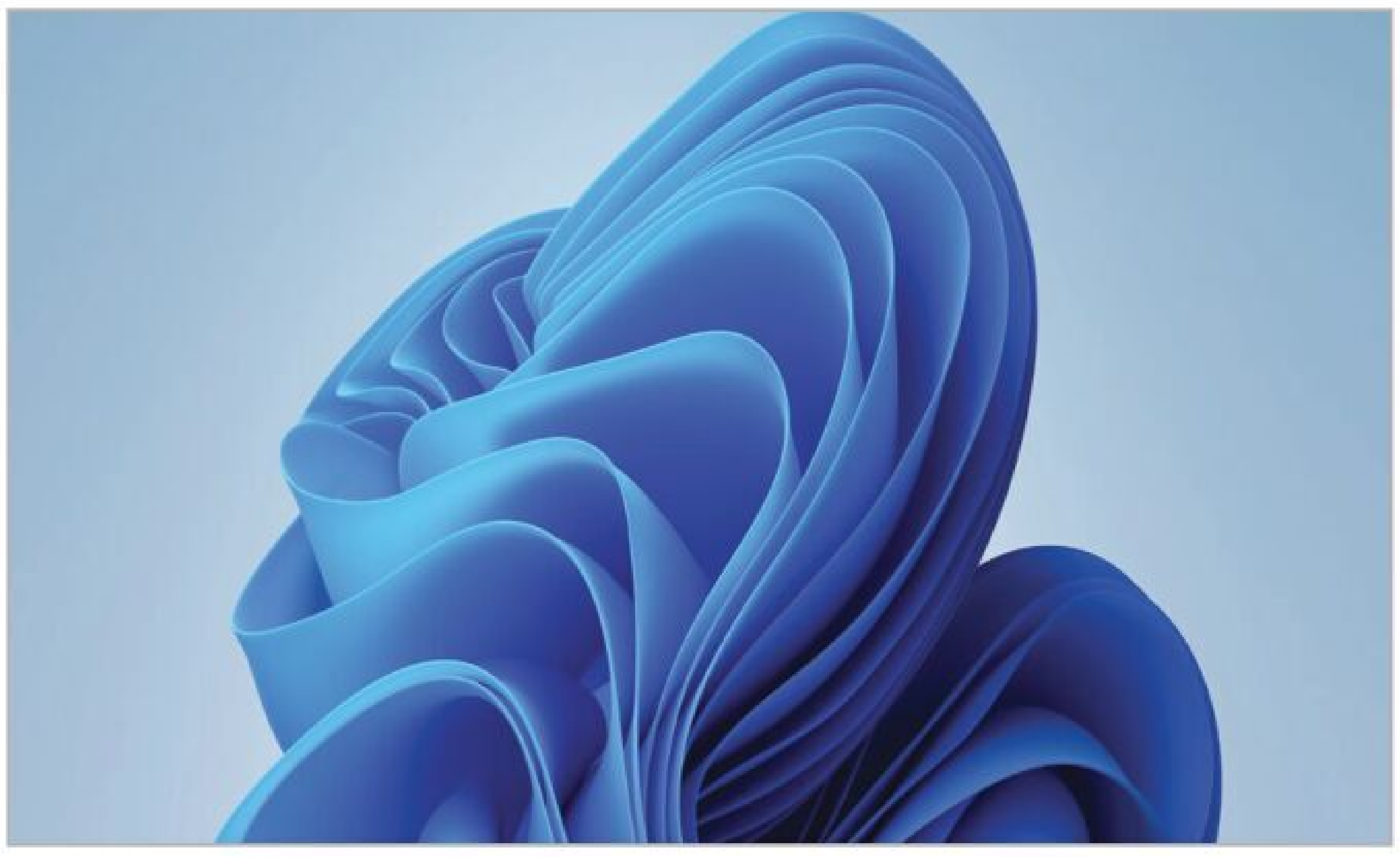
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point conists of an Intel Core i9-11900K, 16GB (2x8GB) Corsair Vengence RGB PRO DDR4 @3600, an MSI GeForce RTX 3070 Gaming X TRIO and a 1TB Samsung 970 Evo Plus M.2 PCIe 3.0 SSD. All game tests are performed at 3840 x 1600 at the highest graphical profile.

© ASUS, MICROSOFT

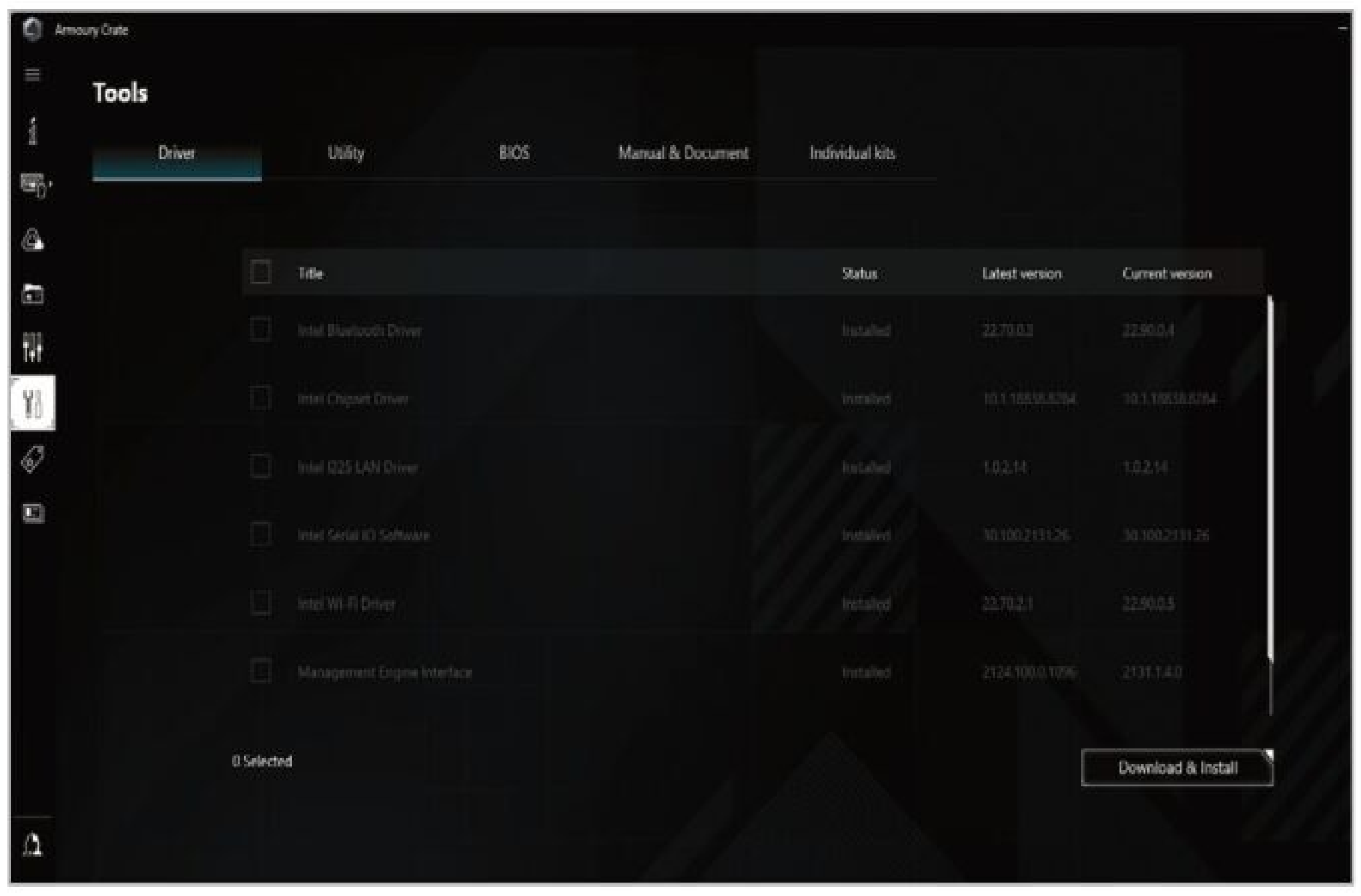
17 WINDOWS 11

USING ANOTHER SYSTEM search for 'Windows 11 media creation tool' and click on the first link to the official Microsoft website. Click on the second option 'Create Windows 11 Installation Media' and download. For this step, you need a clean USB drive of at least 8GB formatted to FAT32. If using the one for the BIOS, make sure to wipe it first. Once downloaded, run the program, and when it gives you the option to choose which media to use, select USB and then the specific drive. This will download a bootable version of Windows 11 to the USB drive. Insert it into your PC, turn the system on, and head to the BIOS by mashing the 'delete' key on startup. In the 'boot' section, change to boot from a USB stick, hit F10 to save and exit. Your system should restart and run through the installation process.



18 UPDATES, DRIVERS, FIRST SOFTWARE

BY THIS STAGE in the build, everything has been put together and we now have Windows 11 running smoothly. However, the PC still needs a few more tweaks to get things properly up and running. First off, we connect it up to the internet and update our ASUS Armory Crate, which is an all-in-one utility for ASUS boards. This has all the necessary drivers to install, plus the chipset for our Intel CPU. With these installed, we headed over to the Windows Update section in the settings just to double-check everything is up to date there too. The final thing we need to do is head over to ninite.com and download our first few pieces of software. Ninite is a great all-in-one solution where you can find all the necessary applications in one place.



Armoury Crate

Tools

Driver | Utility | BIOS | Manual & Document | Individual kits

☐ Title	Status	Latest version	Current version
☐ Intel Bluetooth Driver	Installed	22.70.0.3	22.90.0.4
☐ Intel Chipset Driver	Installed	10.1.18838.8284	10.1.18838.8284
☐ Intel I225 LAN Driver	Installed	1.0.2.14	1.0.2.14
☐ Intel Serial IO Software	Installed	30.100.2131.26	30.100.2131.26
☐ Intel Wi-Fi Driver	Installed	22.70.2.1	22.90.0.5
☐ Management Engine Interface	Installed	2124.100.0.1096	2131.1.4.0

0 Selected

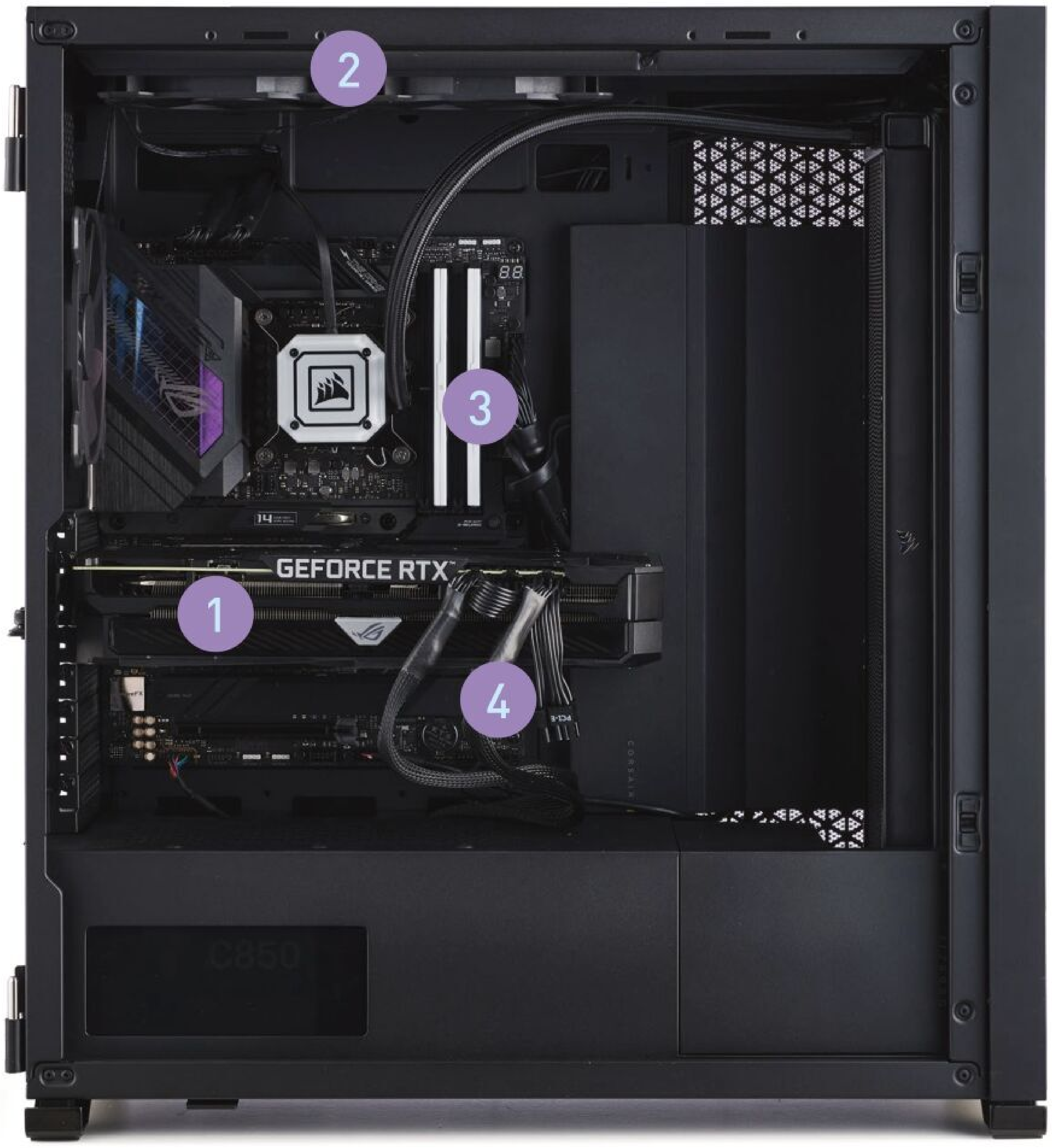
Download & Install

① Even in this huge case, the ASUS ROG STRIX RTX 3080 is a monstrous GPU and performs just as well as it looks. In an ideal world, we would try and swap this out for a 3090 but it was hard enough in the first place to get a 3080.

② To match the lighting with the front of the case, we'd love to replace the stock fans with some of the same fans from our AIO. This should hopefully spruce up the interior of the can a little too.

③ Although we have plenty of RAM in this machine, there is nothing wrong with adding a little more. Four DIMM sticks will look better in this chassis—with only two, it can look a little lonely.

④ Annoyingly on our GPU, there is a loose PCIe cable from the PSU cables that came with our NZXT C850. Next time around, some aftermarket cable solution would sort this solution and look a lot neater around the whole machine.



THE GAME
TO END ALL GAMES
INTEL CORE i9
i9-12900K
SRL4H
V134J271
DIMM_A1
DIMM_A2
DIMM_B1
DIMM_B2
LGA1700

Intel's Core i9-12900K has better performance and efficiency, plus features such as DDR5 and PCIe 5.0 support.

PCIE SLOT
Q-RELEASE

THE EMPIRE STRIKES BACK

We take a closer look at Intel's new Alder Lake CPUs

BY JARROD WALTON

THE GLOVES ARE OFF and Intel has deployed what is arguably its biggest and most ambitious CPU architecture overhaul. Its Alder Lake, 12th-Gen Core processors include major enhancements to improve performance and efficiency, with Intel's first 10nm class (now Intel 7) process technology in a desktop chip. With two new CPU architectures, Golden Cove and Gracemont, this will be the foundation of the next generations of mobile, desktop, and data center processors.

For the past seven years, Intel has watched its processor leadership deteriorate. AMD's Zen 3 architecture boasts high core counts, high instructions per cycle (IPC), high clocks, and efficiency, thanks to a manufacturing process at least a generation ahead of Intel's 14nm parts.

Alder Lake aims to change all that. Intel now offers a legitimate 16-core CPU for consumers, and it can go toe-to-toe with AMD's 16-core offering. What's more, in workloads that don't scale well with raw thread counts (for example, gaming), Intel has focused on boosting IPC while maintaining clock speeds of more than 5GHz. Alder Lake provides Intel with a 19 percent boost to IPC on average while using less power than the previous generation Comet Lake. It's about time we had a compelling upgrade to Intel's desktop offerings, which had stagnated.

We've reviewed the new Core i9-12900K (MPC198) and provided an overview of Intel's various 'Lake' processor families (MPC192). We know Alder Lake performs well in the right situations—such as on Windows 11—but let's dig deeper into the architectures and software that power this new and improved Death Star. Watch out for that thermal exhaust port.

SIX YEARS OF INCREASING POWER

To put it bluntly, Alder Lake and many of its underlying technologies are arriving incredibly late to the party. Intel's first 14nm chips, the Broadwell architecture and 5th Gen Core launched in 2015. Broadwell was mostly a die shrink of the previous generation Haswell chips, combined with a large 128MB eDRAM cache inside the CPU package. Broadwell was also late, which is why the desktop version was almost entirely ignored, but Skylake came out just a few months later as the second iteration of 14nm.

That was the last time Intel officially moved desktops to a smaller manufacturing node. Since then, we have had refinements to the 14nm process to try and keep it competitive. However, you only need to look at power requirements to see that these weren't keeping pace with the competition. Broadwell's i7-5775C had a 65W TDP, whereas Skylake's i7-6700K bumped that up to 91W, and Kaby Lake's i7-7700K stayed with that value. The Coffee Lake i7-8700K added a couple of cores and increased TDP to 95W, but from then on, things started to go downhill pretty quickly.

The i9-9900K was the Coffee Lake refresh and still had a nominal 95W TDP, but peak power (PL2) was set to 210W. Generally speaking, the 9900K never managed to use quite that much power, but it also rarely stayed at or below 95W under load. Comet Lake and the i9-10900K added two more cores and came with a 125W TDP and PL2 increased to 250W. While the CPU should theoretically only run at heightened power draws for up to 56 seconds (Tau), in practice, many enthusiast motherboards simply ignore that value.

Rocket Lake was the final voyage for 14nm and the first time Intel shifted desktops to a fundamentally new CPU core architecture. Everything from Skylake through Comet Lake used variants of the same Skylake core. But Rocket Lake switched to the Cypress Cove architecture, which was derived from the Sunny Cove cores used in the mobile-only 10th Gen Ice Lake CPUs, except that it needed to be backported from 10nm to 14nm. The result was a rather large CPU core, again with high power requirements. The Core i9-11900K has a 125W TDP and 250W PL2 and, under load, tends to stick closer to that 250W limit on most Z590/Z490 motherboards.

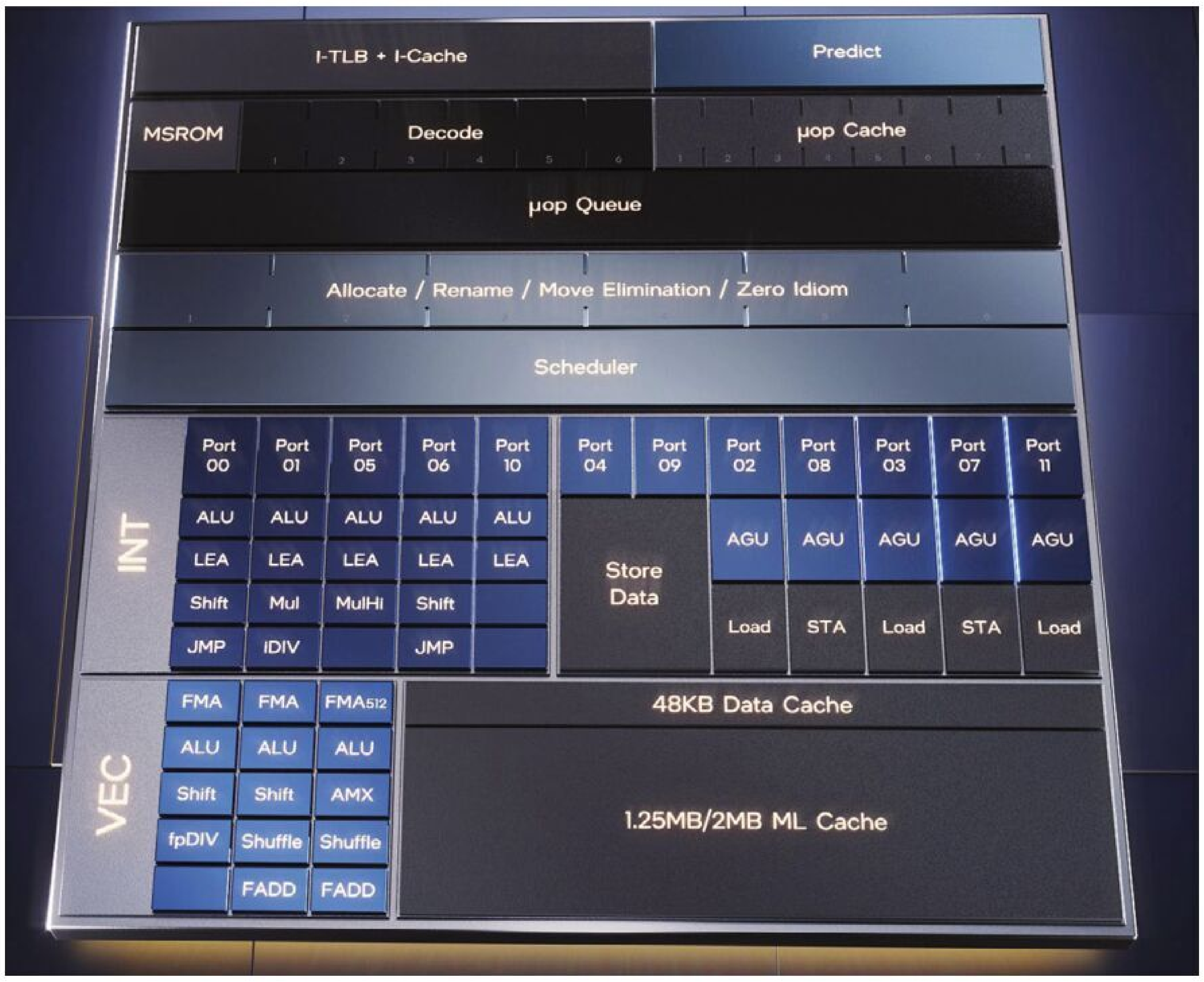
Alder Lake finally ditches the 14nm baggage and moves to a truly new manufacturing node. Formerly called 10nm Enhanced SuperFIN, Intel decided to rename its manufacturing nodes to align with the rest of the industry—meaning TSMC specifically, but also Samsung. That's fair enough, as there's nothing in TSMC's N7 process that actually correlates to 7nm, nor is there anything directly linked to 5nm in the newer N5. Intel makes the claim that its new Intel 7 process basically matches many of the characteristics of TSMC N7, and since the process naming schemes are effectively broken, we'll take that at face value.

AMD has up to 16-core CPUs with the Ryzen 9 5950X, using TSMC N7 running with a 105W TDP. Like Intel's PL2, AMD CPUs can exceed the TDP, but the maximum power consumption is capped at just 142W. While it's certainly possible to make the argument that Intel's Rocket Lake cores can outperform AMD's Zen 3 cores in some single-threaded workloads, the fact that AMD can run 16 cores at around 4.7GHz while using only 142W, Intel's eight cores at 5.1GHz drawing 250W is a serious problem, one that Intel aimed to correct with Alder Lake.

Except that it has only partially addressed that issue. The Alder Lake i9-12900K still comes with a 125W TDP, but Intel has now changed nomenclature and lists MTP, or Maximum Turbo Power. This is still PL2, but there's no longer a time limit (Tau) for how long a chip can stay at MTP, and Intel doesn't list an official TDP. MTP on the 12900K did drop a bit, to 241W, but that's still 70 percent higher than AMD's maximum 142W. The difference is that per-core performance has improved—and by a lot.

Across a suite of single-threaded tests, the 12900K comes in 19 percent faster than the Core i9-11900K and the Ryzen 9 5950X. It also leads the 5950X in many multi-threaded workloads. Power use is still higher, but efficiency is far more competitive than the previous generation 14nm chips.

Intel's mantra for Alder Lake was "Wider, Deeper, Smarter." That meant more execution ports and deeper buffers, among other changes.



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GOLDEN COVE PERFORMANCE CORES

We've seen hybrid processor designs in the world of Arm chips for a while, and Intel has dabbled with them for its Lakefield processors. Those had four "efficiency" cores and one "performance" core, using the Tremont (used in recent Atom, Pentium Silver, and Celeron CPUs) and Sunny Cove (i.e., Icelake) architectures, respectively. Launched in mid-2020, Intel has already retired Lakefield, but it was likely more of a proof of concept. With the groundwork laid, Alder Lake is taking the hybrid core approach with x86 to new levels.

The star of the show is the big and powerful Golden Cove cores. Golden Cove is the logical successor to the Intel CPU cores we're familiar with—meaning, the previous generation Icelake and Rocket Lake cores, which followed the various Skylake derivatives. Each Golden Cove core supports Hyper-Threading, Intel's name for symmetric multi-threading (SMT) where a single core can execute code from two different instruction threads at the same time, sharing some of its resources.

Golden Cove was designed as the performance building block for all of Intel's upcoming CPUs, so it will see use in everything from low-power laptop chips to massive Xeon processors used in the data center. Along with various improvements to the pipelines and buffers, one interesting tidbit is that Golden Cove supports AVX512… but it's disabled in the consumer desktop parts. That's because AVX512 is more for certain data center workloads, and because Intel wanted a unified instruction set for the Golden Cove and Gracemont cores—and Gracemont doesn't support AVX512.

Intel followed the mantra of "Wider, Deeper, Smarter" with the Golden Cove architecture. Key improvements include a 6-wide instruction decoder (up from 4-wide in previous architectures) coupled with a 6-wide microarchitecture (up from 5-wide in Sunny Cove). The micro-op cache has increased from 2.25K to 4K entries, and there are now 12 execution ports instead of ten in the previous architecture. The re-order buffer is also larger, with 512 entries (vs. 352 in Rocket Lake). There's also a fifth integer ALU (arithmetic logic unit), and the L2 cache per core has increased to 1.25MB (up from 512KB)—or 2MB on server parts (up from 1.25MB).

Golden Cove includes other refinements too, like a faster 1-cycle LEA (Load Effective Address) instruction on all five ALU ports, a new fast adder, and there's a third load port, with deeper and larger load and store buffers. The FP16 (16-bit floating-point) format is now supported by AVX512—or it will be on future Sapphire Rapids data center CPUs. Intel has also added a new AMX (Advanced Matrix Extensions) instruction set, which can compute up to 2048 int8 operations concurrently. It's like the tensor cores we've seen in Nvidia's recent GPUs, except in Intel's CPU cores. Like AVX512, AMX support has been disabled for consumer Alder Lake parts.

© INTEL

XE GRAPHICS RIDES AGAIN

Intel's Alder Lake uses the same Xe Graphics (Gen12 GPU) that we've already seen in 11th Gen Tiger Lake and Rocket Lake processors. This is still Xe LP DG1, in other words, not an updated DG2 with additional features like ray tracing hardware and matrix cores. It's been scaled down to the Intel 7 node from Rocket Lake, with clock speeds reaching up to 1.55GHz. That's 250MHz higher than the 14nm Xe Graphics used in Rocket Lake, but it's not going to compete with any competent graphics card.

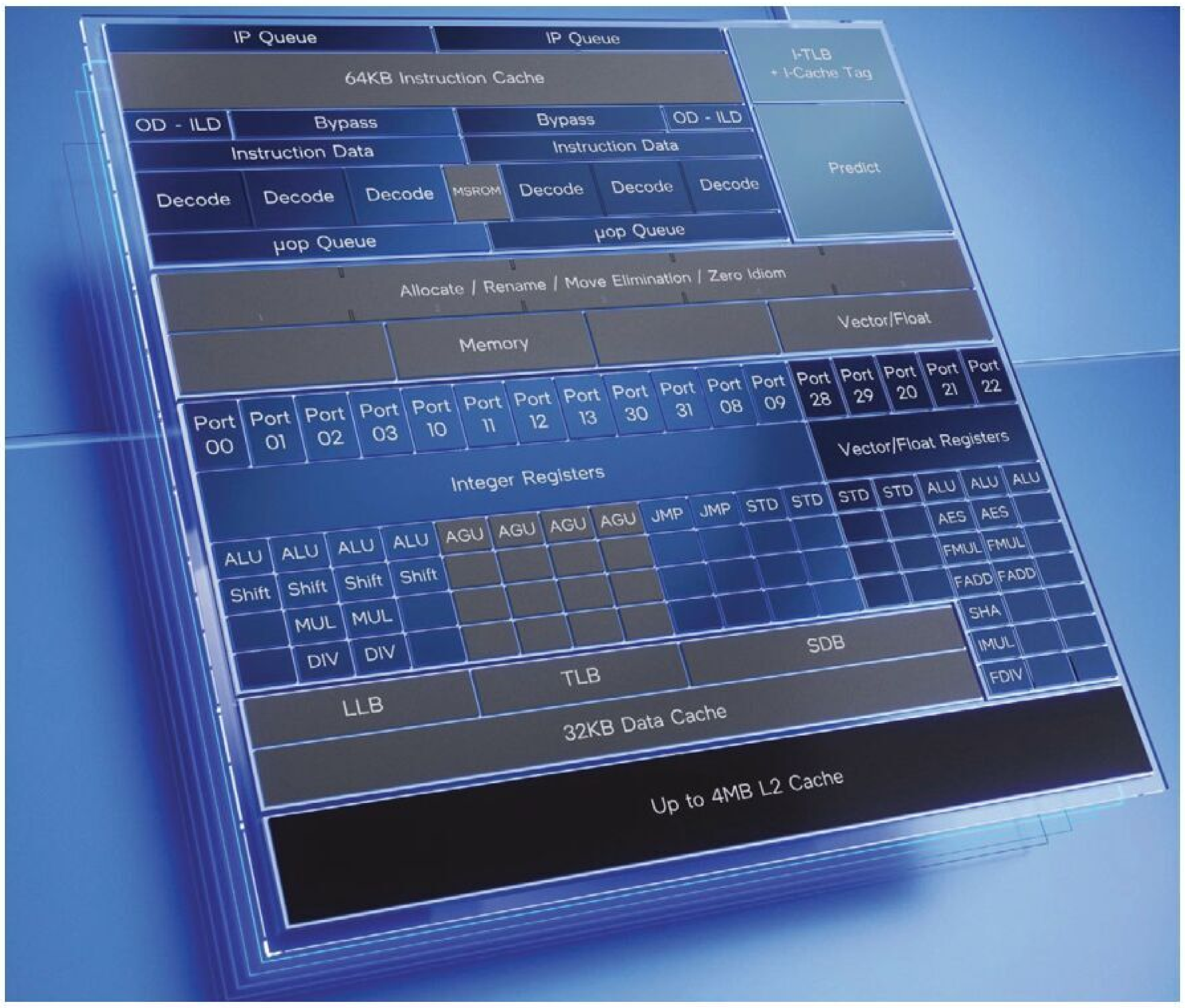
Intel provides up to 32 EUs (execution units), with a theoretical compute rate of just 794 GFLOPS—yes, it's so slow that we're back to GFLOPS instead of TFLOPS. The relatively anemic GTX 1050 should be about three times as fast, while a more recent "budget" GPU (shortages notwithstanding) like the GTX 1650 Super potentially delivers six times the performance of the UHD 770.

As we've said before, Intel's goal isn't to displace dedicated GPUs—a market it will be entering shortly with its Arc graphics portfolio. Instead, integrated graphics on the desktop and high-end laptop parts is about providing a decent set of base functionality that won't use a lot of power. The UHD 770 includes HEVC, VP9, and SCC encoders that support up to 4K60 HDR content, and hardware-accelerated AV1 decode support for 4K60 as well.

Nope, Intel isn't planning on stuffing its latest Arc GPUs into Alder Lake, though it might show up in the 13th Gen Raptor Lake.

GRACEMONT EFFICIENCY CORES

The other half of the CPU cores comes via the Gracemont architecture. This is the third generation out-of-order Atom architecture—the first two Atom architectures were in-order designs. A Gracemont core is like taking a Skylake core, stripping out some of the cruft, using a smaller but faster cache, and simplifying it so you have a small and efficient processor core. According to Intel,


IP Queue
IP Queue
64KB Instruction Cache
I-TLB + I-Cache Tag
OD - ILD
Bypass
Bypass
OD - ILD
Instruction Data
Instruction Data
Predict
Decode
Decode
Decode
MSROM
Decode
Decode
Decode
μop Queue
μop Queue
Allocate / Rename / Move Elimination / Zero Idiom
Memory
Vector/Float
Port 00
Port 01
Port 02
Port 03
Port 10
Port 11
Port 12
Port 13
Port 30
Port 31
Port 08
Port 09
Port 28
Port 29
Port 20
Port 21
Port 22
Integer Registers
Vector/Float Registers
ALU
ALU
ALU
ALU
AGU
AGU
AGU
AGU
JMP
JMP
STD
STD
STD
STD
ALU
ALU
ALU
Shift
Shift
Shift
Shift
AES
AES
MUL
MUL
FMUL
FMUL
DIV
DIV
FADD
FADD
SHA
IMUL
FDIV
LLB
TLB
SDB
32KB Data Cache
Up to 4MB L2 Cache

The Gracemont architecture overview looks more complex than Golden Cove, but despite having more ports, it's much smaller and more efficient.

Gracemont cores are faster in many ways than the original Skylake cores from 2015.

As an example, Intel compared Gracemont against Skylake using SPECrate2017_int_base. It provided 40 percent higher performance using the same amount of power, or the same performance with 40 percent less power. Even better, using a multi-threaded test and comparing a 4-core Gracemont configuration against a 2-core/4-thread Skylake chip, Gracemont provided 80 percent more performance at the same power, or used 80 percent less power at the same ISO performance. Hyper-Threading only provides about a 20 percent uplift in performance compared to adding a physical core, but the data is still promising as far as power efficiency goes.

The problem is that Intel and other processor companies like to play games with statements about power and efficiency. Intel locked the clocks on Gracemont cores to the sweet spot in terms of efficiency to maximize those numbers. In the real world, we've done testing that suggests eight E-cores running at up to 3.9GHz ends up delivering a similar experience to an older Core i5-9400 (6-core, no Hyper-Threading, running at up to 4.1GHz). The E-cores often lead in general application performance, but trail in gaming capabilities. The kicker? Power consumption on the 12900K running only the E-cores ended up being slightly higher than the i5-9400. But there were still die space savings.

In terms of trimming the fat, Gracemont features a clustered design with dual 3-wide instruction decoders. This apparently allows for a similar level of efficiency when compared with a narrower 3-wide design, but it still allows for decoding up to six instructions per cycle. Intel also focused on improving the branch efficiency (relative to the previous Tremont architecture) via a 5,000-entry branch target cache.

Where things get a bit wild is when we start looking at the execution ports. Gracemont features a 5-wide instruction allocation and 8-wide retire design, but it has 17 different execution ports. Each of these ports tends to be simplified relative to the Golden Cove equivalents, and Intel says the arrangement delivers higher integer IPC than Skylake at a fraction of the power cost. The execution ports consist of four integer ALUs, two load and two store AGUs (address generation units), two jump ports two integer store data ports, two floating-point/vector store data ports, and finally two FP/vector stacks with a third vector ALU.

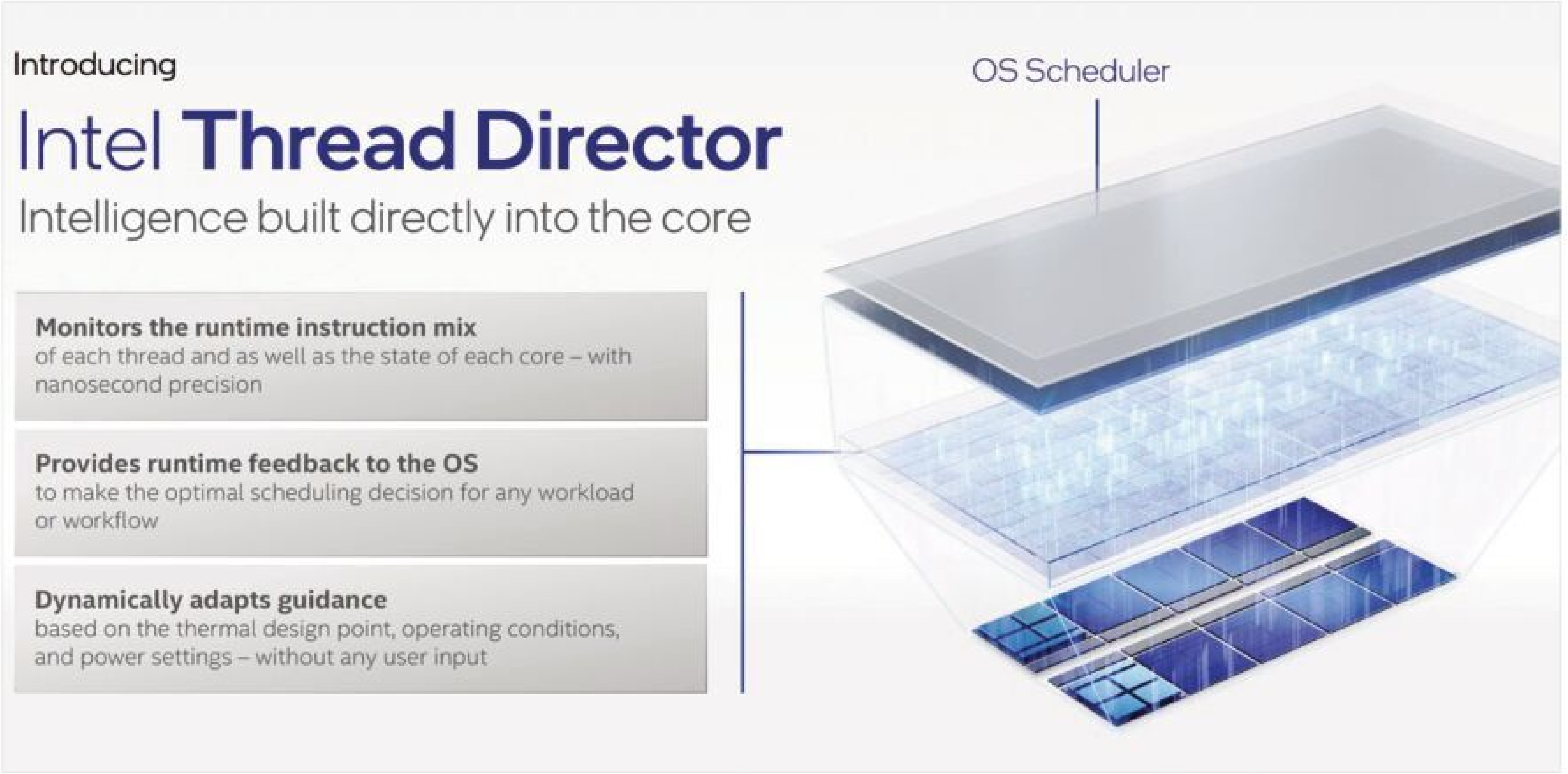
In terms of cache, each core gets a 64KB instruction cache and a 32KB data cache—that's a 33 percent smaller data cache than Golden Cove. Instead of individual L2 caches, however, a cluster of four Gracemont cores can share a 2MB L2 cache (4MB on data center variants).

Gracemont cores are designed to run at lower voltages, and since power scales with the square of voltage, that helps a lot with making them more efficient. Because of that design parameter, Gracemont cores also won't clock nearly as high as Golden Cove. Where the maximum turbo clocks on Golden Cove cores can reach 5.2GHz, Gracemont cores peak at a relatively tame 3.9GHz. That's lower than the Skylake 6700K's 4.2GHz max boost clock, six years later, all in the name of efficiency.

One interesting point here is that die shots of Alder Lake indicate that Intel can cram four Gracemont cores into approximately the same area as a single Golden Cove core. The Core i9-12900K has eight Golden Cove and eight Gracemont cores, but a hypothetical Gracemont-only design could have put 40 Gracemont cores into the same die area.

We are likely to see designs in the future that omit all Golden Cove cores and simply use a whole bunch of Gracemont cores, but those will probably be for servers rather than desktop users.

Alder Lake needs more complex and intelligent thread scheduling to maximize performance—Windows 11, in other words.


Introducing

Intel **Thread Director**

Intelligence built directly into the core

Monitors the runtime instruction mix
of each thread and as well as the state of each core – with nanosecond precision

Provides runtime feedback to the OS
to make the optimal scheduling decision for any workload or workflow

Dynamically adapts guidance
based on the thermal design point, operating conditions, and power settings – without any user input

OS Scheduler

© INTEL

WINDOWS 11 & THE THREAD DIRECTOR

The difficulty with a hybrid CPU design like Alder Lake is that it requires a certain amount of intelligence in both the hardware and the software to make everything run optimally. With a top-tier part like the 12900K, sending latency-sensitive or demanding workloads to the E-cores could make the system feel sluggish while sending less demanding work to the P-cores can burn extra power.

Ideally, the CPU needs to schedule lighter tasks to the E-cores and heavier tasks that require real-time responsiveness to the P-cores. When something wants to use the maximum computing power of the processor and spawns dozens of threads, then it can use both P-cores and E-cores. Intel has created a hardware solution that's responsible for this decision-making, called the Thread Director.

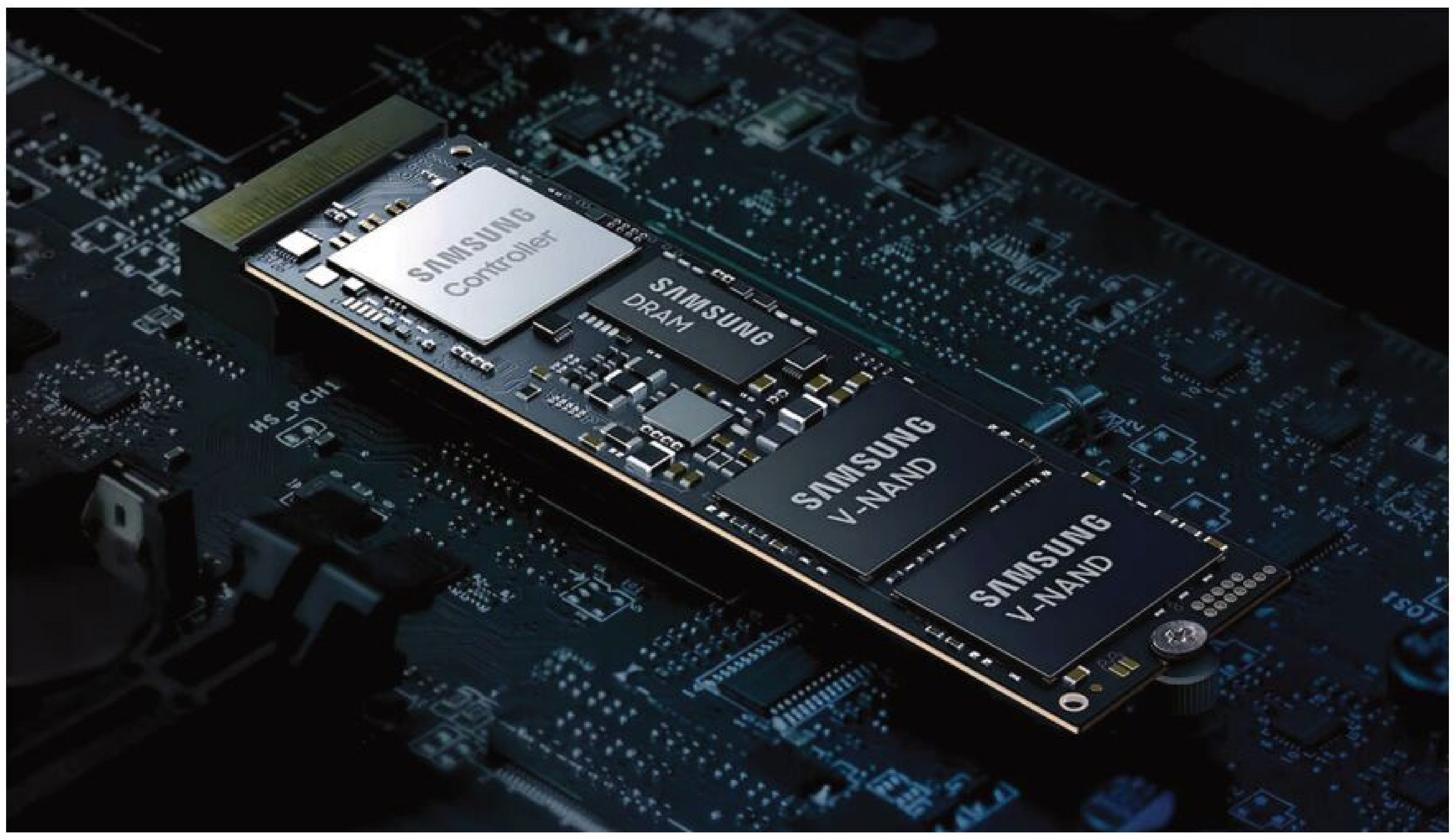
The Thread Director uses a trained AI model to identify different workloads at the chip level and can provide telemetry data to the OS so that it knows where to send work. The problem is that Windows 10 uses static scheduling of threads and while it may be aware of hybrid cores, it doesn't query the telemetry data the CPU provides to determine where to send work. This can result in a less than perfect experience when running Windows 10 on an Alder Lake CPU with both P-cores and E-cores, and the solution is to simply run Windows 11.

Windows 11 uses the full feature set of the Thread Director. That's the good news. If you plan to buy an Alder Lake CPU or a prebuilt Alder Lake system, you should plan on using Windows 11. But as we've noted already, that can be a bit of a contentious point. Windows 11 makes enough changes to the UI and user experience that quite a few people are seriously put off with Microsoft's latest OS.

Alternatively, you can still run Windows 10, and Intel claims that the difference in performance usually only amounts to a few percent. We set about testing that, and while many applications show performance fluctuations of less than five percent, there are enough exceptions that it's a concern.

We saw what can only be classified as a terrible performance from Alder Lake—both the i9-12900K and i5-12600K—in Corona, y-cruncher (single- and multi-threaded modes), POV-Ray (single- and multi-core), HandBrake x264 encoding, and more. Using Windows 10, there are quite a few cases where the 12900K falls behind even the Ryzen 5 5600X and previous generation i5-11600K, and the 12600X performs even worse. Run those same tests on Windows 11 and Alder Lake often tops even AMD's fastest Ryzen 9 5950X.

One of the main issues appears to be Windows 10 scheduling any threads designated as lower priority to the E-cores, regardless of how much CPU time they're using. It's possible to work around these problems using various utilities to prevent certain applications from running with a low priority level, but that gets messy and confusing for a lot of people. Patches to the various software packages might also improve the situation in the coming months. For the time being, we strongly recommend using Windows 11 as the foundation of any Alder Lake system.



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PCI EXPRESS 5.0

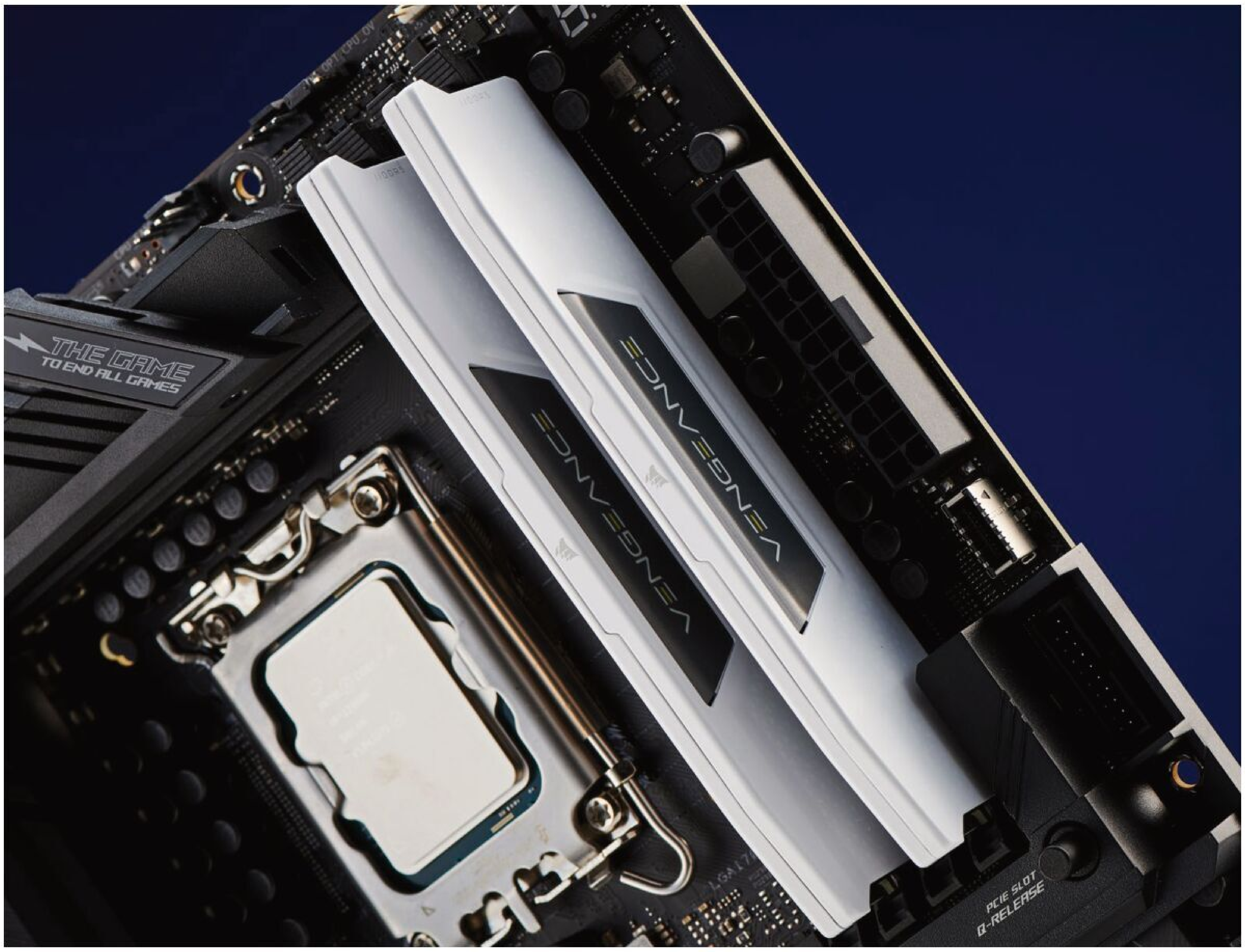
Alder Lake will be the first consumer platform to support PCIe Gen5 devices, but actual support may vary by motherboard and processor. We know that most Z690 motherboards theoretically have support for PCIe Gen5, but we don't have the hardware to test that support just yet. Both the latest graphics cards and the latest M.2 SSDs are still sitting in Gen4 land, but we should see Gen5 SSDs at least arrive this year.

One thing we don't expect is widespread support for PCIe Gen5 on laptops. In fact, right now most shipping laptops are still using PCIe Gen3 SSDs because the minor gains in normal workloads from a faster Gen4 SSD don't measure up to the increased power requirements and loss of battery life.

It's an interesting change in position for Intel, after being late to the PCIe Gen4 party—support for that only arrived with Rocket Lake and Z590 processors and chipsets. AMD already supported Gen4 with its Zen 2 Ryzen 3000 processors, launched in 2019, two years ahead of Intel's 11th Gen CPUs. Now Intel is ahead of AMD, as well as Nvidia and the various SSD providers. Most people won't need that doubled bandwidth any time soon, but it will be beneficial in the data center.

Samsung has already teased an upcoming PCIe Gen5 SSD. There's no word yet on performance, but the x4 interface provides up to 15.7 GB/s of throughput.

Also note that Intel doubled the speed of the DMI interface between the chipset and the CPU with Alder Lake. It's basically the equivalent of a PCIe Gen4 x8 interface now, double the bandwidth of the DMI 3.0 x8 interface on Rocket Lake and quadruple the bandwidth on Comet Lake and earlier chips. That wider interface means motherboards can hang more Gen4 M.2 slots off the PCH and still have full performance on any attached SSDs.



DDR5 memory is the new hotness, but in practice it's hit and miss. Games often run better with DDR4, while media encoding tends to prefer DDR5's raw bandwidth.

THE CHOICE BETWEEN DDR4 AND DDR5

Alder Lake supports DDR5, the first PC platform to do so. It also supports DDR4 memory. The promise of memory speeds of up to 4800MHz (effective) might sound enticing, but there's more to it than raw memory bandwidth. DDR5 uses PMICs (Power Management Integrated Circuits) on the DIMMs, and as such, it comes with different requirements.

First, you need to look at the memory latency along with the speed. Typical DDR5-4800 memory comes rated with CAS latencies of 40, and subtimings are also rated at 38–40. That might be 50 percent more bandwidth than DDR4-3200 can provide, but the actual latency is worse. DDR4-3200 CL16 has an actual latency of 10ns, while DDR5-4800 CL40 has 16.7ns latency. Other factors come into play, but using Intel's officially supported memory speeds of DDR4-3200 or DDR5-4400, it's a mixed bag of results. Some applications and games prefer DDR4, others prefer DDR5.

If it were just performance, we could move on, but the choice between DDR4 and DDR5 has wide-ranging implications. First, much like graphics cards, DDR5 is currently sold out. Hopefully, the supply will improve, but recommended prices for DDR5 2x16GB kits range from $280–$350, and prices are currently heading in the wrong direction. A similar capacity DDR4 kit will only set you back about $75–$100.

There's also the question of what motherboard you want to use. If you prefer high-end ones, you are limited to DDR5 designs. Conversely, if you want a DDR4 motherboard, the highest quality options are at best classified as midrange solutions. We're okay with midrange motherboards in general, but pairing a top-tier CPU and cooler with a modest motherboard is a bit odd.

You won't find any motherboards with both DDR4 and DDR5 slots. The reason is that DDR5 has much more stringent signaling requirements, so it needs more board layers and the routing of traces needs to be more precise. Trying to support two memory types gets in the way, and people willing to pay the price premium for a DDR5 board likely won't want to be restricted to using just two DIMMs. If you run at stock-supported speeds, also note that you can only run at DDR5-4800 if your board has just two physical slots; otherwise, you're limited to DDR5-4400.

As if that wasn't enough, there's also the matter of memory gears. Like other recent processors, Alder Lake can run its memory at a 1:1 ratio (Gear 1), or it can use a 2:1 ratio (Gear 2). It performs best with Gear 1, but that will typically only get you up to around DDR4-4000 or DDR5-4000. Luck of the draw will be a factor, but DDR4 defaults to Gear 1 all the way up to the officially supported DDR4-3200, while DDR5 runs in Gear 2 by default and requires Gear 2 for speeds above 4000MHz.

ALDER LAKE: A BRAVE NEW WORLD

Intel's latest architecture is undoubtedly one of the most complex undertakings in the history of the company. Creating one new architecture requires plenty of effort. Moving to a new process node involves another huge chunk of work. Couple that with the second new CPU architecture, plus the hybrid core design with its need for updated software, then add in support for DDR5 and PCIe 5. It's a massive undertaking, and it mostly pays off.

Intel has matched AMD's Ryzen 5000 series in terms of raw core counts, though it trails in the total number of threads. The new Golden Cove architecture more than makes up for that in most tests, and Alder Lake can now lay claim to the overall desktop performance throne. It's not a perfect victory, however.

Power and efficiency tend to favor AMD's Zen 3 architecture. Intel's talk about how efficient the E-cores can be sounds good, but in the real world, at the clock speeds Intel is pushing, the 12900K still sucks down a substantial amount of juice. That's mainly because the E-cores aren't about competing with AMD; they're meant to fend off Arm.

You only need to look to Apple to see Intel's Arm fears made manifest. Several years back, Arm and smartphones were one of the biggest threats to Windows PCs. We're still happily running Windows 10, but Apple has ditched Intel for its own homegrown M1, and now the M1 Pro and M1 Max are kicking things up a notch. Apple's control of both the hardware and software running on its Macs gives it a lot of opportunities to tune performance, and we're witnessing the results of those efforts. The M1 Max might not be able to beat a Windows desktop in every task, but it wins enough to be a serious threat.

Intel's answer is a rather large 19 percent boost to IPC on the Golden Cove cores, but just as important are the efficient Gracemont cores. In fact, the next generation Raptor Lake processors will apparently double down on the E-cores, so we'll get a chip with the same eight P-cores as the 12900K, but with sixteen E-cores. The new design philosophy appears to be providing enough high-performance cores to take care of tasks that need higher IPC and clock speeds, but for workloads that are able to scale with lots of cores and threads, spamming a bunch of lower performance but more efficient cores can ultimately lead to a better overall result.

For its part, AMD's Zen 4 architecture appears to be sticking with a more traditional approach—it won't feature a hybrid architecture. But given the proliferation of big.Little in the Arm arena and with Intel now moving to a hybrid design, don't be surprised to see that Zen 5 or Zen 6 end up mixing different types of cores.

With 14nm finally fading in the rearview mirrors, Intel has plans to quickly move to 7nm-class, 5nm-class, and then 3nm-class processes. It fell behind the competition, TSMC and Samsung, during the past seven years, but plans a decisive return to the lead. While Alder Lake is the first step in that direction, TSMC is already shipping 5nm-parts and talking about 3nm production starting in 2023. Intel still has plenty of work to do.

Overclocking headroom on Alder Lake appears to be very impressive—liquid nitrogen not required.

WELCOME BACK, OVERCLOCKING

Overclocking is far more satisfying with Alder Lake than we've seen on many other recent CPU launches. Make no mistake, Alder Lake can use a lot of power and thus needs good cooling if you want to push beyond stock speeds, and there's not a massive amount of headroom at the top. However, unlike AMD's Ryzen CPUs, it's possible to tweak clocks based on how many cores are active, and there are a lot of other knobs to tweak.

The E-cores, as you'd expect, tend to benefit less from pushing higher clocks. The P-cores meanwhile can generally hit 5.3GHz on a good motherboard without batting an eye. Compare that to AMD's overclocking, which often requires you to reduce maximum single-core clocks to hit higher all-core overclocks. What's more, there are a lot of possibilities for improving performance by tuning the memory subsystem.

It's too early for us to provide a detailed Alder Lake overclocking guide, but so far sticking with Gear 1 and pushing memory clocks as high as you can reach with stability seems to be the way to go. DDR5 modules are also in their infancy, so we could see much higher memory clocks down the road—and maybe Gear 2 will become more useful when we're talking about DDR5-8000. And if you're into extreme overclocking using LN2? Professional overclockers have already eclipsed 7GHz.

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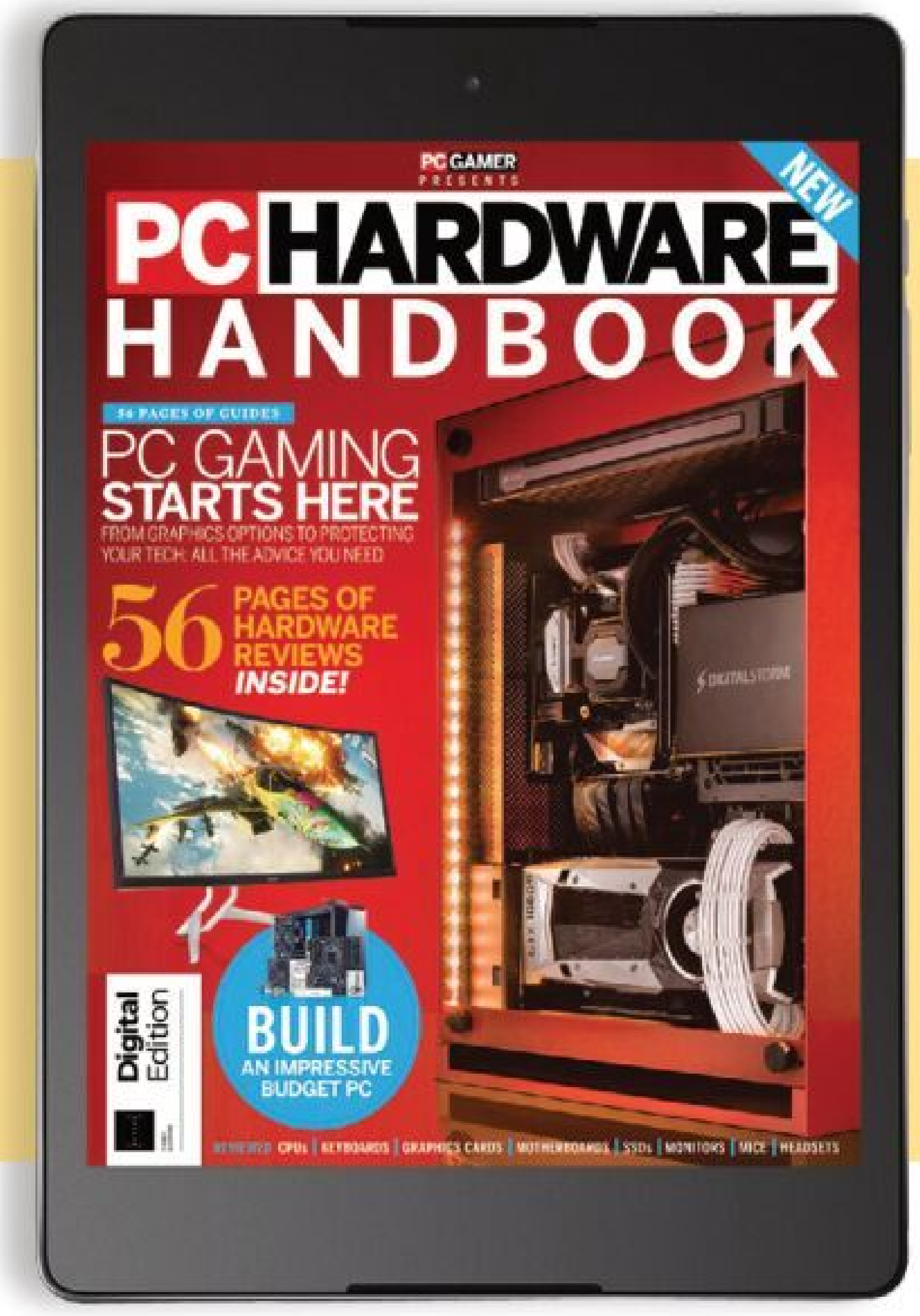
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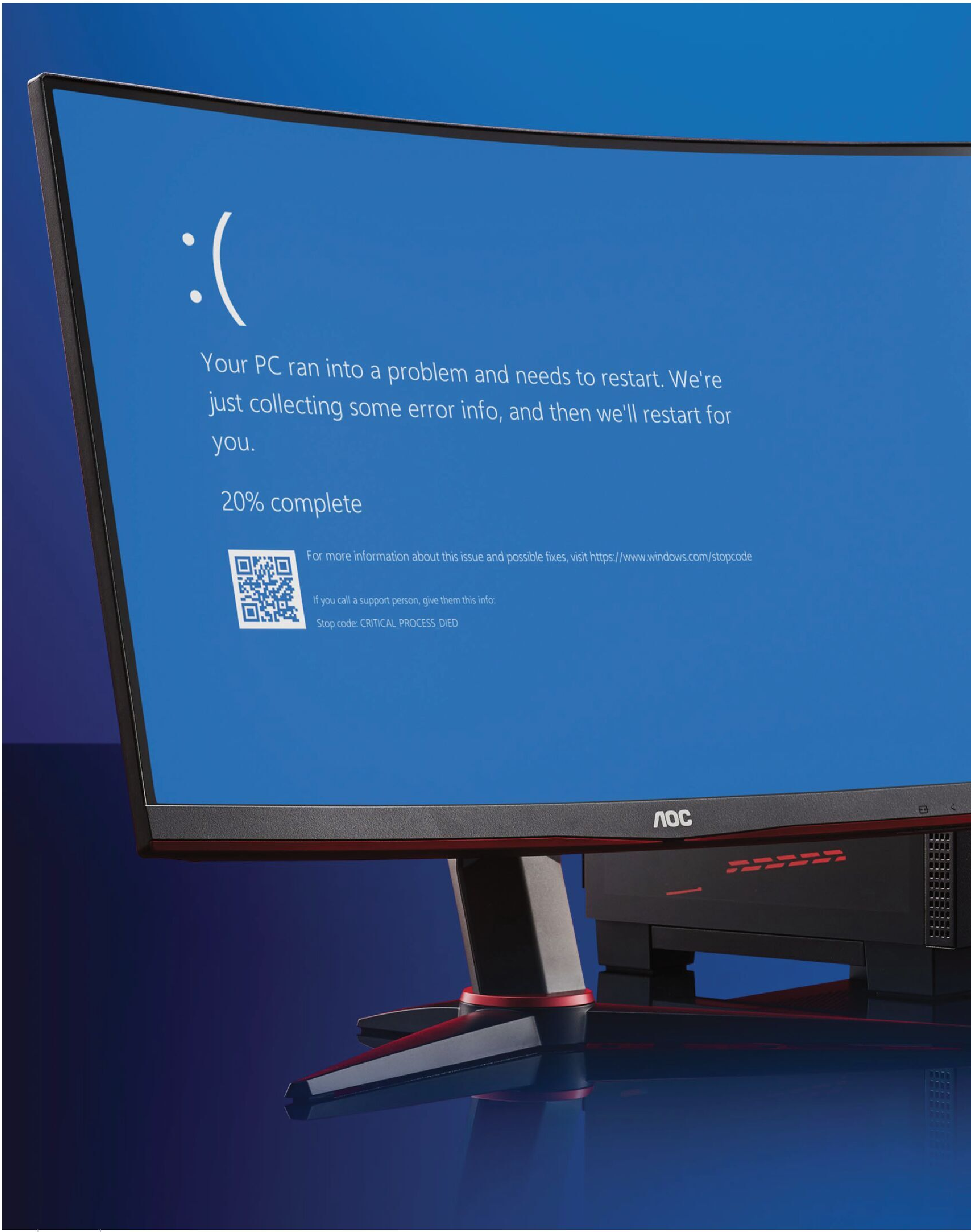


:(

Your PC ran into a problem and needs to restart. We're just collecting some error info, and then we'll restart for you.

20% complete

For more information about this issue and possible fixes, visit https://www.windows.com/stopcode

If you call a support person, give them this info:

Stop code: CRITICAL_PROCESS_DIED

SAVE OUR SYSTEMS!

Discover how to fix your Windows problems large and small with the help of *Nick Peers*.

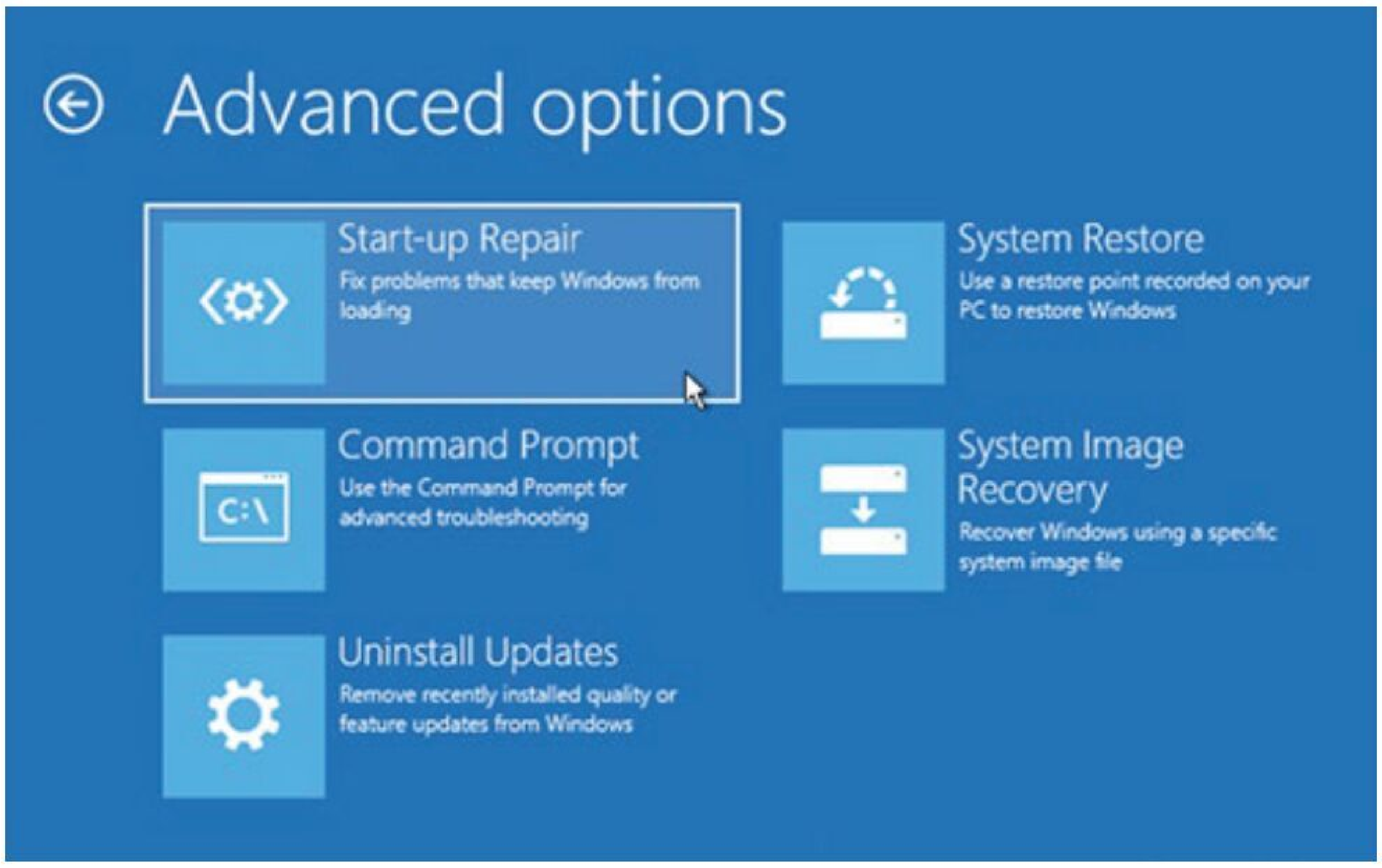
BENJAMIN FRANKLIN famously said that an ounce of preparation is worth a pound of care, but when it comes to troubleshooting Windows problems there's only so much you can set up in advance. Even with the best backup regimen in the world, you can't always inoculate yourself against a Windows error, crash, or complete meltdown.

Don't worry though, because armed with a few tips and techniques, you'll be well-equipped to deal with the worst that Windows can throw at you. We'll start with the most catastrophic circumstances—a Windows installation that refuses to boot successfully to the desktop. You'll learn how to combine Windows' own troubleshooting tools with a powerful (and free!) third-party rescue disc to maximize your chances of fixing the problem. And if you can't get Windows to boot again, we'll reveal how to recover important files from the disk before performing a full reinstall.

Even when you can boot into Windows successfully, the problems don't stop there. We'll take you through some useful troubleshooting techniques covering a range of issues, from Windows Update to problems with USB peripherals and issues with non-responsive or freezing applications. And to help you tackle these problems with the minimum of fuss, we'll namecheck some free tools designed to diagnose and fix problems on your behalf.

If you can't find the solution to your specific problem from our advice, no worries. We reveal the key tools and techniques you can employ to diagnose and fix problems, and information to gather (and where to find it) to help you hunt for a fix online. If all else fails, we'll also show you how to perform a 'repair' installation that will attempt to refresh Windows without wiping any programs, settings, or data, helping you to fix more deep-seated problems without reaching for the nuclear button.

Whether your Windows-related issue is a minor irritant or of major concern, you'll discover how to take back control of your PC and potentially save your system from a needless full-blown reinstall.



Advanced options

Start-up Repair
Fix problems that keep Windows from loading

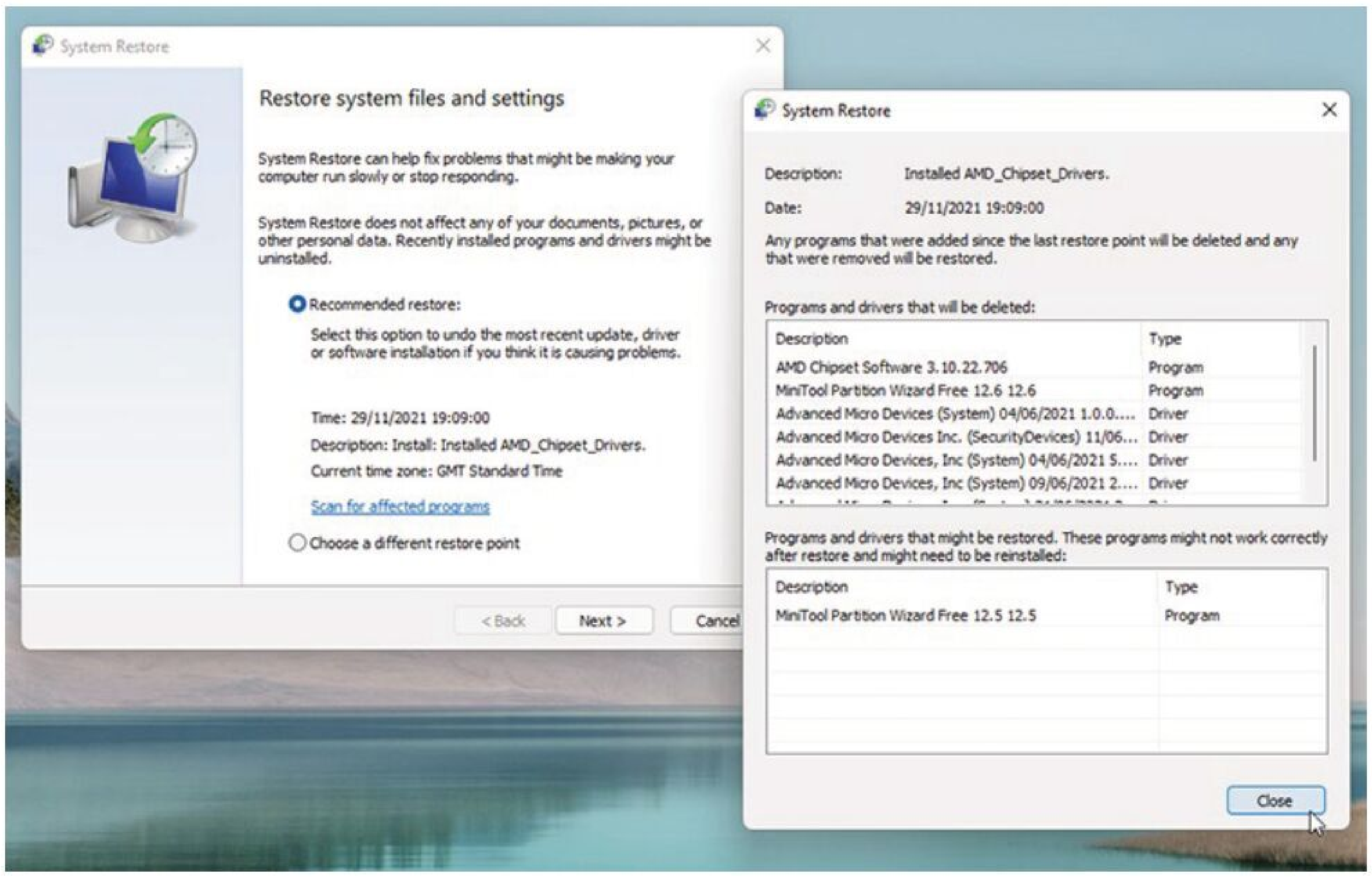
System Restore
Use a restore point recorded on your PC to restore Windows

Command Prompt
Use the Command Prompt for advanced troubleshooting

System Image Recovery
Recover Windows using a specific system image file

Uninstall Updates
Remove recently installed quality or feature updates from Windows

Windows offers a selection of limited recovery tools. This should be your first port of call.



System Restore

Restore system files and settings

System Restore can help fix problems that might be making your computer run slowly or stop responding.

System Restore does not affect any of your documents, pictures, or other personal data. Recently installed programs and drivers might be uninstalled.

● Recommended restore:

Select this option to undo the most recent update, driver or software installation if you think it is causing problems.

Time: 29/11/2021 19:09:00
Description: Install: Installed AMD_Chipset_Drivers.
Current time zone: GMT Standard Time

Scan for affected programs

○ Choose a different restore point

System Restore

Description: Installed AMD_Chipset_Drivers.
Date: 29/11/2021 19:09:00

Any programs that were added since the last restore point will be deleted and any that were removed will be restored.

Programs and drivers that will be deleted:

Description	Type
AMD Chipset Software 3.10.22.706	Program
MiniTool Partition Wizard Free 12.6 12.6	Program
Advanced Micro Devices (System) 04/06/2021 1.0.0....	Driver
Advanced Micro Devices Inc. (SecurityDevices) 11/06...	Driver
Advanced Micro Devices, Inc (System) 04/06/2021 5....	Driver
Advanced Micro Devices, Inc (System) 09/06/2021 2....	Driver

Programs and drivers that might be restored. These programs might not work correctly after restore and might need to be reinstalled:

Description	Type
MiniTool Partition Wizard Free 12.5 12.5	Program

With Windows repair tools, you may be able to roll your system back to a working state.

Windows problems come in all shapes and sizes, so let's start by taking a look at the biggest problem likely to come your way: boot failure. If you've not yet created any rescue media, you'll be forced to rely on Windows' own troubleshooting tools, so let's see what's available.

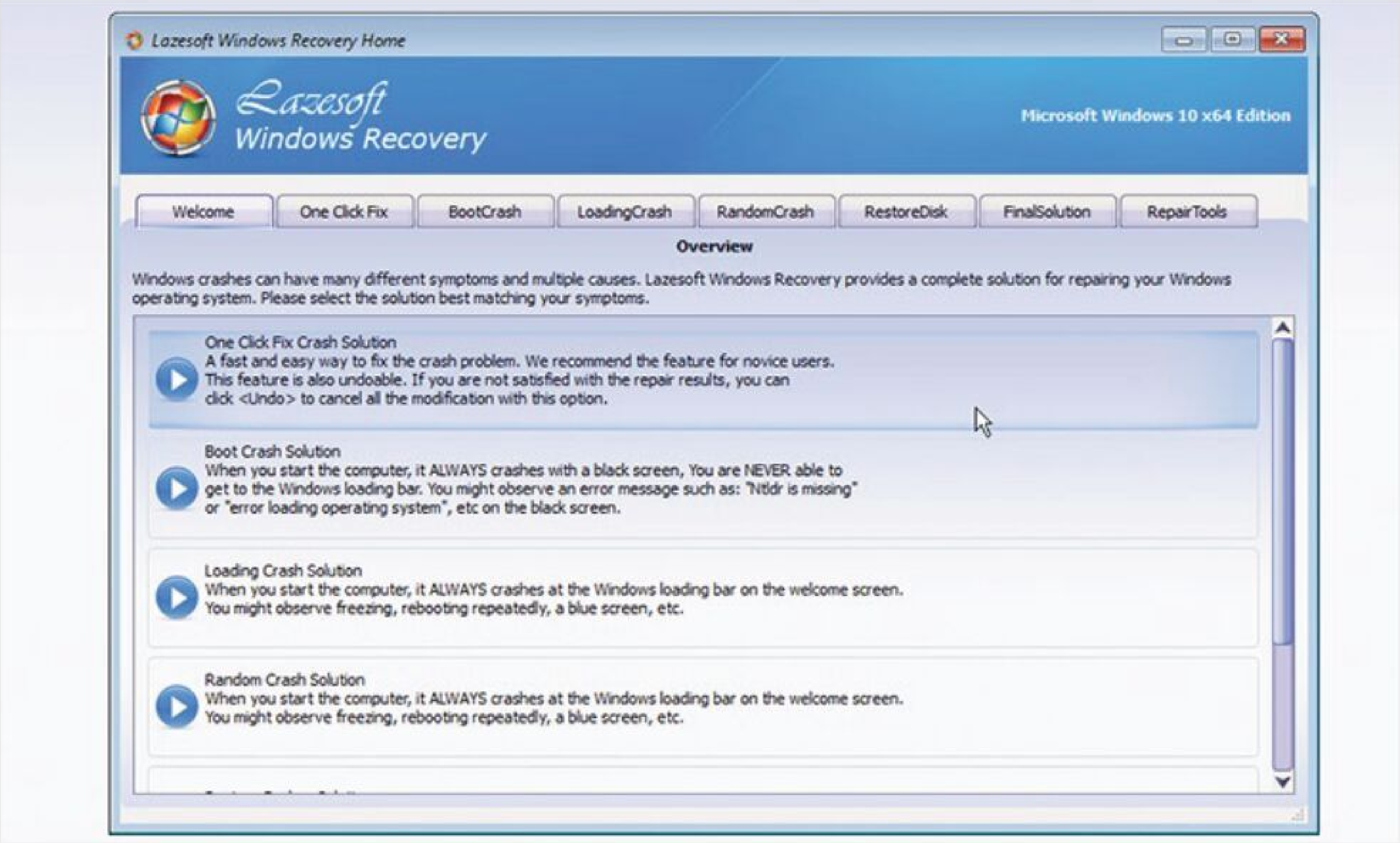
First, we're going to assume your PC has passed all basic hardware checks on first boot, your UEFI or BIOS has been able to detect your Windows boot drive and handed control to it to start loading Windows. If no bootable operating system has been found, it's possible the drive has failed. You'll need to boot to a recovery environment to see if the drive is still physically visible—Lazesoft Recovery Suite is a good tool for the job, and we'll explain how to use it later on.

Assuming the drive is detected, and you're able to see evidence that Windows has started to load before running into problems, you should find Windows' own automatic startup repair tool has sprung into action after a failed boot operation. It may run several times, rebooting between each attempt, so sit back and be patient. If you're lucky, Windows will now load; if you aren't, it should eventually bring up the advanced start-up tool with the all-important Troubleshoot button under 'Choose an option'.

The next step depends on your circumstances. For example, if you're unable to start Windows after installing a recent feature or quality update—in the case of Windows 10, the most recent major update is the 21H2 update—then try 'Uninstall Updates'. First, choose the type of update you want to remove, select Windows 10, and click the uninstall button.

Failing that, if System Restore hasn't been disabled, you may be able to roll your system back to a working state if you suspect a recent driver or program update or installation is to blame. Select it from the menu, then click Windows 10 or 11 and wait for it to load. A list of all available Restore points will be shown. Choose the latest one and click 'Scan for affected programs' to see what drivers and applications will be affected. Make a note, then click Next followed by Finish to roll your system back.

The final 'easy' option available from Windows' own troubleshooting tools relies on you continuing to use the Backup and Restore (Windows 7) tool to back up your hard drive via a system image. If so, you can restore the last backup taken using the System Image Recovery tool. It should detect your latest image and roll your PC back to a working state. If you've backed up using Macrium Reflect, use its rescue media to bring Windows back to the point your last backup was taken.



Overview

Windows crashes can have many different symptoms and multiple causes. Lazesoft Windows Recovery provides a complete solution for repairing your Windows operating system. Please select the solution best matching your symptoms.

One Click Fix Crash Solution
A fast and easy way to fix the crash problem. We recommend the feature for novice users. This feature is also undoable. If you are not satisfied with the repair results, you can click <Undo> to cancel all the modification with this option.

Boot Crash Solution
When you start the computer, it ALWAYS crashes with a black screen, You are NEVER able to get to the Windows loading bar. You might observe an error message such as: "Ntldr is missing" or "error loading operating system", etc on the black screen.

Loading Crash Solution
When you start the computer, it ALWAYS crashes at the Windows loading bar on the welcome screen. You might observe freezing, rebooting repeatedly, a blue screen, etc.

Random Crash Solution
When you start the computer, it ALWAYS crashes at the Windows loading bar on the welcome screen. You might observe freezing, rebooting repeatedly, a blue screen, etc.

Lazesoft's Recovery Suite is our go-to tool for identifying common boot problems.

© MICROSOFT

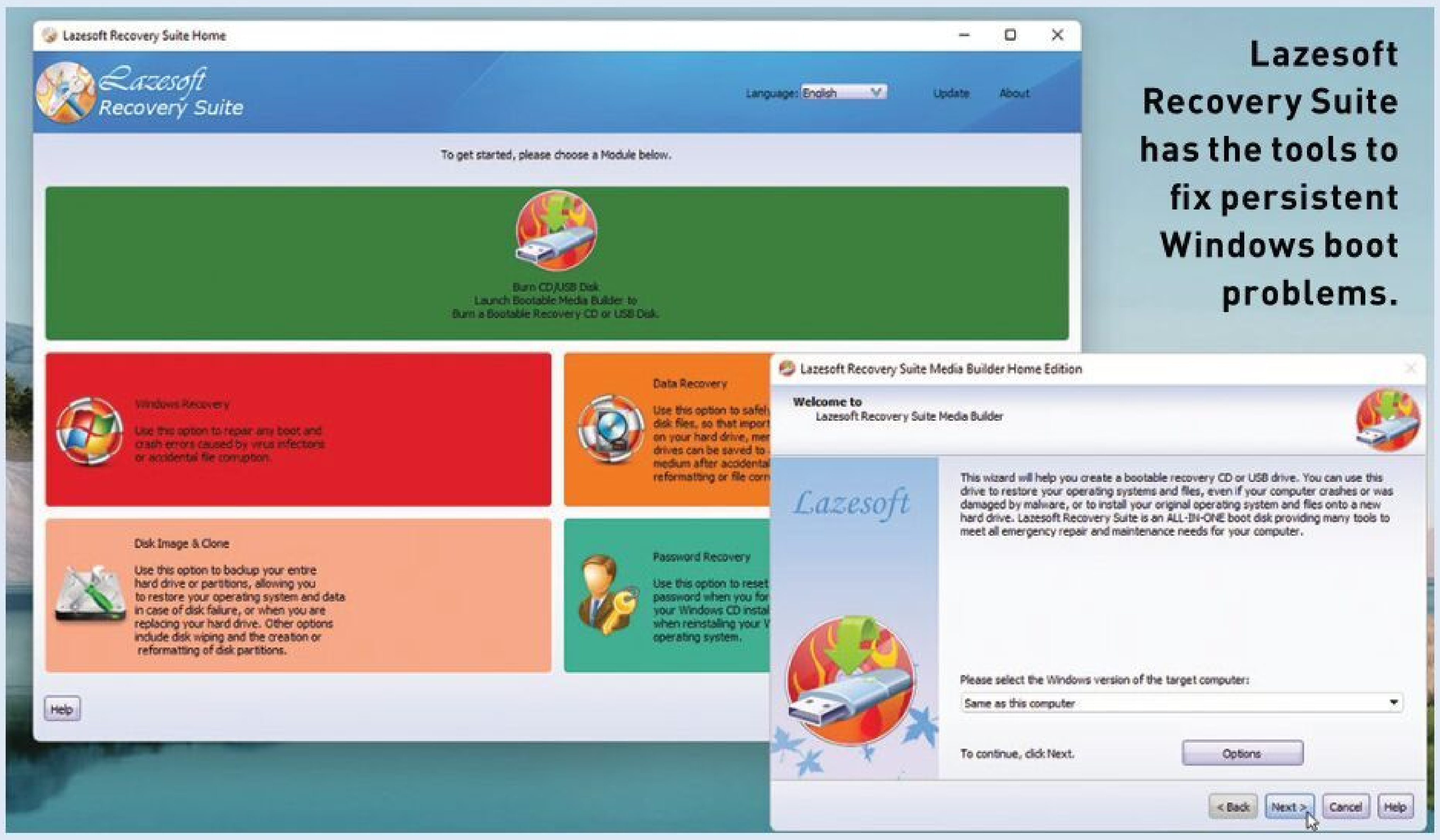
If none of these options work, you'll need to drop into a command prompt to continue troubleshooting. Choose Command Prompt and Windows will drop you into the temporary RAM drive (X:\) created by the Windows Recovery Environment (WRE). Begin by seeing if the Start-up Repair tool has managed to log the problem in the SrtTrail.txt file, which will help you target a solution. The file is stored on your Windows boot drive under Windows\System32\logfiles\srt\, but don't assume the boot drive has been assigned the letter C by the WRE.

To see which letter it has been assigned, type '`diskpart`' and hit Enter, then type '`list volume`' and hit Enter. Once verified, type the following, substituting C:\ with whichever drive letter it's been given:

```
cd C:\Windows\System32\logfiles\srt\
SrtTrail.txt
```

The file's contents will be displayed, allowing you to review its findings and pinpoint problems the Start-up Repair tool may have been able to identify but without being able to fix, for example, corrupt boot files.

When it comes to applying manual fixes, the bootrec tool is just one of several available to you from the Command Prompt. Others include diskpart, chkdsk, and DISM. Typing the tool's name and pressing Enter will bring up a list of supported commands for that tool, but if you find it all a little off-putting, check out the box to find out how to create a bootable Lazesoft Recovery disc or drive, then carry on.



To get started, please choose a Module below.

Launch Bootable Media Builder to Burn a Bootable Recovery CD or USB Disk.

Use this option to repair any boot and crash errors caused by virus infections or accidental file corruption.

Use this option to safel disk files, so that import on your hard drive, mer drives can be saved to medium after accidental reformatting or file corr

Use this option to backup your entire hard drive or partitions, allowing you to restore your operating system and data in case of disk failure, or when you are replacing your hard drive. Other options include disk wiping and the creation or reformatting of disk partitions.

Use this option to reset password when you for your Windows CD instal when reinstalling your W operating system.

Welcome to Lazesoft Recovery Suite Media Builder

This wizard will help you create a bootable recovery CD or USB drive. You can use this drive to restore your operating systems and files, even if your computer crashes or was damaged by malware, or to install your original operating system and files onto a new hard drive. Lazesoft Recovery Suite is an ALL-IN-ONE boot disk providing many tools to meet all emergency repair and maintenance needs for your computer.

Please select the Windows version of the target computer: Same as this computer

To continue, click Next.

Lazesoft Recovery Suite has the tools to fix persistent Windows boot problems.

BUILD A RECOVERY DISC

Windows' built-in repair tools can only do so much, so if you find that they are falling short, then it's time to call in the cavalry.

Lazesoft Recovery Suite is our go-to tool when it comes to taking on stubborn boot problems. Not only does it offer a wider range of repair tools, but there are also tools for recovering data from crashed (but readable) drives as well as the option of taking a fail-safe image of your entire corrupted Windows installation. This ensures that you won't lose any files, even if you end up with no other choice but to hit the nuclear option.

In an ideal world, you'll have a Lazesoft recovery disc or USB flash drive ready to go but if not, you'll need access to a working PC. Browse www.lazesoft.com on that and click Download, choosing the free Home Edition download. Once that has downloaded, install the program and click on the 'Burn CD/USB Disk' option.

If your working PC is running a different version of Windows, select the correct version from the dropdown menu before clicking Next. Note, at the time of writing, version 4.5.1 of the software didn't explicitly support the latest version of Windows; however, we were able to install, build and boot from a disc using Windows 11. You can burn this to CD, copy it to a spare flash drive (2GB or larger), or create an ISO file you can subsequently add to your Ventoy boot disc.

Once created, test the media: restart your PC with it in the drive, then tap whichever key is listed to bring up the boot menu (typically F11 or F12). From here, select your USB drive—choose UEFI if offered the choice—and when the Windows Boot Manager appears, leave 'Lazesoft Live CD (EMS Enabled)' selected before hitting Enter.

A SIMPLER FIX

Once you've booted to the Lazesoft Recovery desktop, first take steps to copy any unprotected data on your drive to a backup drive. If you plan to copy it over the network, you'll first need to assign the network drive a letter: click Start and choose 'Map Network Drive' first. Specify its address (try its IP address in place of its server name if you can't connect), select a drive letter, and enter the required network credentials if necessary.

The Lazesoft File Manager icon on the desktop provides a simple two-pane file explorer tool for manually copying individual files and folders, or you can make use of the Data Recovery tool, which can transfer regular files as well as recover deleted files and files from lost partitions. Select your scanning level (choose 'Fast' for non-recovery scenarios), choose the drive containing your data and click Start Search. After a short period, you'll be able to search the drive by file path or file type, then select which files you want to recover before clicking 'Save Files' to select a drive and folder to copy them to.

If you're not sure which files you might be missing, back up the entire drive: click 'Disk Image & Clone' followed by 'Backup (Drive to Image)'. Select drive C and click Next. Leave Full Backup selected and click Browse to select your destination followed by Start to take the backup. Should you need to recover files from this drive image in future, install Lazesoft on your PC, then launch it in Windows. Open 'Disk Image & Clone, then click 'Browse Drive Image File' under Drive Image.

REPAIR YOUR WINDOWS INSTALLATION

With your failsafe backups in place, open Windows Recovery, select your Windows installation if necessary, and click OK. At the Overview screen, click the 'One Click Fix Crash Solution' option. Click 'One Click Fix' to run the wizard. Review the results and click Finish.

If the one-click fix doesn't solve your problem, examine the BootCrash tab, where you'll see a selection of individual tools from MBR Repair to Missing Windows File Repair. Select one and if it matches your symptoms, click the button to apply it. Failing that, the LoadingCrash tab offers more tools, including shortcuts to Windows tools like System Restore and System File Checker, as well as some of Lazesoft's own, such as the Registry Recovery tool. This latter tool will attempt to detect and fix Registry corruption. Some programs may need reinstalling if this succeeds, so use it as a last resort.

Windows Recovery helps steer you towards the appropriate solution for your symptoms. If the one-click option has no effect, take the time to select each tool and read its description, which includes a guide to the types of symptoms the tool can remedy. After all this, if you're still unable to get Windows to work, it's time to bite the bullet and look to repair or reinstall Windows. See the box for details.

FIX COMMON WINDOWS PROBLEMS

Most issues with Windows are less severe, so let's take a look at a selection of common ones before resorting to more generic troubleshooting tools and techniques. First, what happens if Windows rejects your password or PIN when trying to log in? These days, virtually everyone will be logging on using their Microsoft Account, however, if you're still using a local account, then one possible option is to use the Lazesoft Recovery disc's Recover My Password tool to clear the account password and start from scratch with a new one.

If you're logging in with a Microsoft Account, then to go https://account.live.com/password/reset and follow the prompts to reset your password. Once done, you should hopefully be able to log into your Windows account again. As a side note, if you're trying to troubleshoot a problem in Safe mode, but Windows keeps rejecting your password, it may be because you changed your password after installing Windows on that PC, so you'll need to try and remember your original password and use that instead to log in.

CAN'T SLEEP, WON'T SLEEP

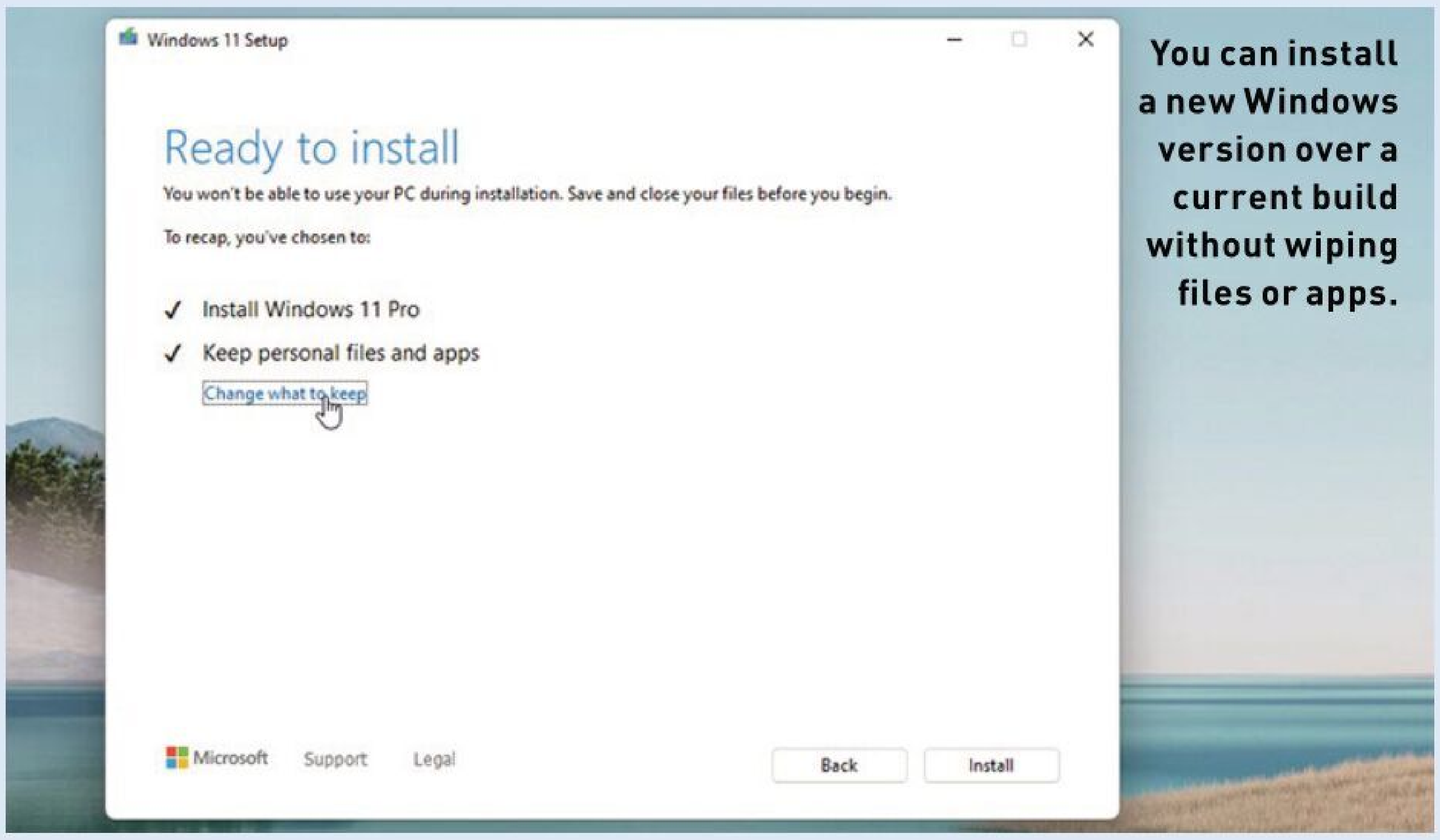
Does your PC struggle to stay asleep? Open an administrative command prompt by right-clicking the Start button. Choose Windows Terminal (Admin) in Windows 11. Type powercfg /lastwake and hit Enter. This will tell you the last thing to wake your PC, which can form the basis of your troubleshooting following our advice at the end of this feature. If you'd like to see which services, apps, or drivers can wake your PC, try powercfg /waketimers followed by powerfg /requests.

You can also use powercfg to provide a detailed report of your energy and power usage, including potential problems using the 'powercfg /energy' command. After 60 seconds, open the C drive and look for a file called 'energy-report.html', which you can also examine for clues to diagnose your wake-related problem.

USB ISSUES

Sleep-related issues can often be traced to an errant USB device, which leads us to more generic USB issues that can cause problems. Some of these involve your USB chipset drivers, which vary according to your motherboard. Right-click Start and choose Device Manager, then expand the Universal Serial Bus controllers. Double-click each Host Controller in turn and switch to the Driver tab to identify the controller and its current driver version.

By default, Windows will install its own set of drivers for these controllers where possible—in most cases, that



Ready to install

You won't be able to use your PC during installation. Save and close your files before you begin.

To recap, you've chosen to:

✓ Install Windows 11 Pro

✓ Keep personal files and apps

Change what to keep

You can install a new Windows version over a current build without wiping files or apps.

REPAIR OR REINSTALL?

Sometimes, you can't fix your Windows problem following any number of tools or steps. At times like these, it's tempting to reach for the 'nuclear' option and reinstall Windows from scratch, but sometimes you can get away by 'upgrading' your Windows installation by installing a fresh version over the top of your current build without wiping data, settings, or applications.

This 'repair' installation requires you to create Windows installation media—you can download the tool for burning a DVD or writing to a spare, unused 8GB flash drive from https://www.microsoft.com/en-us/software-download/windows11 or www.microsoft.com/en-us/software-download/windows10 depending on your version of Windows. Alternatively, Windows 11 users can download the ISO file directly, then double-click it to mount the file as a virtual DVD in File Explorer.

From here, open the drive and double-click setup.exe, then follow the prompts to start the installation process including downloading any updates if they're required. After everything is ready, you'll be prompted what type of install you wish to perform. Make sure 'Keep personal files and apps' is selected before clicking Install (if necessary, click 'Change what to keep' to select it). From this point on, Windows will reinstall itself, rebooting when necessary to eventually return you to your desktop, with the problem hopefully fixed.

If you're looking for a more drastic fix, but one that doesn't involve losing any personal files on your system drive, you can also reinstall Windows via Settings – navigate to System → Recovery → Reset this PC. You'll see there's no option to preserve settings and apps, so only consider this if Windows is falling apart at the seams and you're unable to take final backups of data and your system using tools like Macrium Reflect; otherwise, update your backups one last time and consider wiping the drive clean and starting completely from scratch using your newly created installation media.

should be fine, but if not, go to your PC or motherboard manufacturer's website and see if there are dedicated USB or chipset drivers to download and install.

If you encounter any error codes for USB devices or ports in Device Manager, download USB Repair (www.rizonesoft.com/downloads/), which may be able to provide a swift resolution to your problem.

If you're struggling to identify what devices are connected to which USB ports, use the free HWiNFO (www.hwinfo.com) tool. From the main window, expand Ports → USB to view all hubs. Expand each one further beyond its Root Hub to determine which device is plugged into which controller. If certain devices on the same controller appear to be conflicting with each other, try moving them on to separate controllers.

A related issue may occur with devices you have plugged into your front-mounted USB ports. These ports are less 'stable' than the rear ones, particularly with wireless devices and those that draw their power from the USB port. Always try to plug these types of more permanent connections into the rear ports where possible, saving your front-mounted ports for USB flash drives and other easily removable devices.

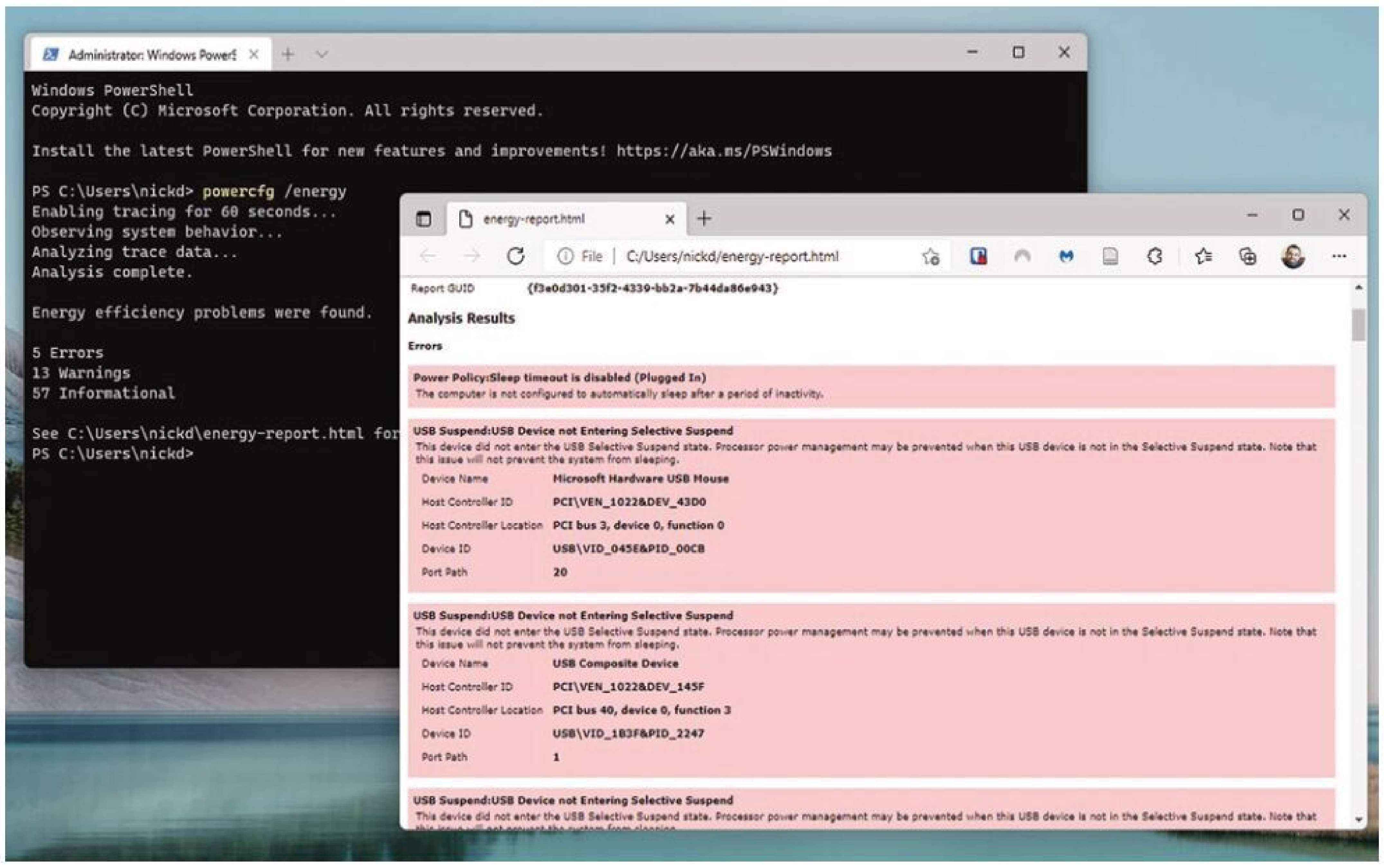
TROUBLESHOOT WINDOWS UPDATE

If Windows Update refuses to work correctly, for example, if it throws up errors when you attempt to install an update or scan for updates, or you're struggling to install a specific update, then start by running the Windows Update troubleshooter to see what it finds: type 'windows update' into the search tool and click 'Find and fix problems with Windows Update'.

Click Next and wait while the tool scans for issues. If it finds and fixes any, click 'View detailed information' to find out more about the fix, then click Close, reboot, and try again. If the fix in question involves installing pending updates, but it's those updates refusing to install that is causing the problem, click 'Skip this fix' to keep searching for other potential issues.

If the problem persists, you may need to perform some more drastic steps. Check out the box on the left for details of how to use the free Windows Repair tool to attempt a fix for this—and other Windows-related problems.

If you are struggling to update to a newer version of Windows (or the latest feature update), use the Update Assistant (www.microsoft.com/en-us/software-download/windows10) to handle the process for you. Be patient, this process may take several hours and involve multiple reboots.


Administrator: Windows PowerS
energy-report.html
File | C:/Users/nickd/energy-report.html

```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\nickd> powercfg /energy
Enabling tracing for 60 seconds...
Observing system behavior...
Analyzing trace data...
Analysis complete.

Energy efficiency problems were found.

5 Errors
13 Warnings
57 Informational

See C:\Users\nickd\energy-report.html for
PS C:\Users\nickd>
```

Report GUID {f3e0d301-35f2-4339-bb2a-7b44da86e943}

Analysis Results

Errors

Power Policy:Sleep timeout is disabled (Plugged In)
The computer is not configured to automatically sleep after a period of inactivity.

USB Suspend:USB Device not Entering Selective Suspend
This device did not enter the USB Selective Suspend state. Processor power management may be prevented when this USB device is not in the Selective Suspend state. Note that this issue will not prevent the system from sleeping.

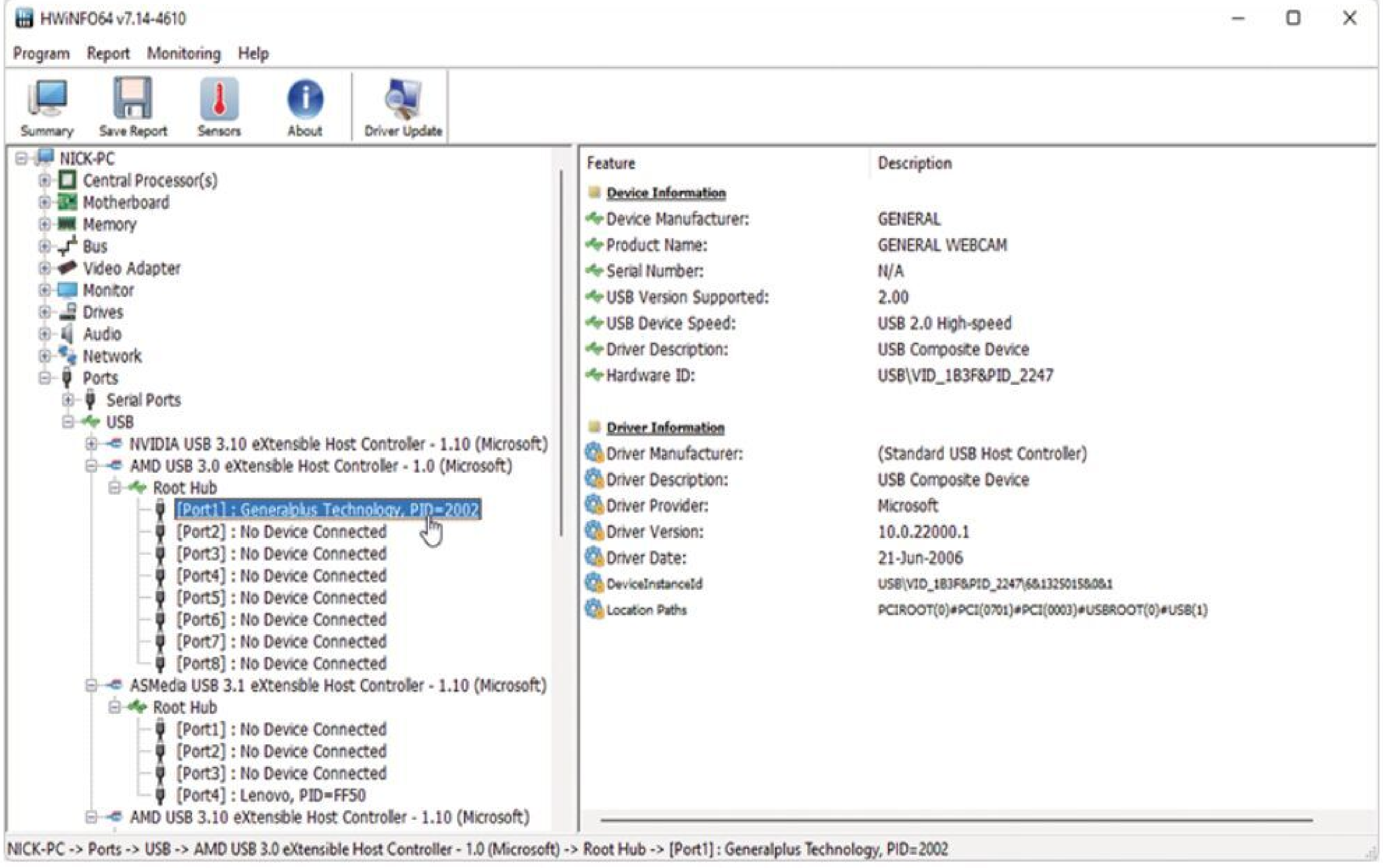
Device Name	Microsoft Hardware USB Mouse
Host Controller ID	PCI\VEN_1022&DEV_43D0
Host Controller Location	PCI bus 3, device 0, function 0
Device ID	USB\VID_045E&PID_00CB
Port Path	20

USB Suspend:USB Device not Entering Selective Suspend
This device did not enter the USB Selective Suspend state. Processor power management may be prevented when this USB device is not in the Selective Suspend state. Note that this issue will not prevent the system from sleeping.

Device Name	USB Composite Device
Host Controller ID	PCI\VEN_1022&DEV_145F
Host Controller Location	PCI bus 40, device 0, function 3
Device ID	USB\VID_1B3F&PID_2247
Port Path	1

USB Suspend:USB Device not Entering Selective Suspend
This device did not enter the USB Selective Suspend state. Processor power management may be prevented when this USB device is not in the Selective Suspend state. Note that

If your PC is struggling to stay asleep, you can analyze what's waking it up.

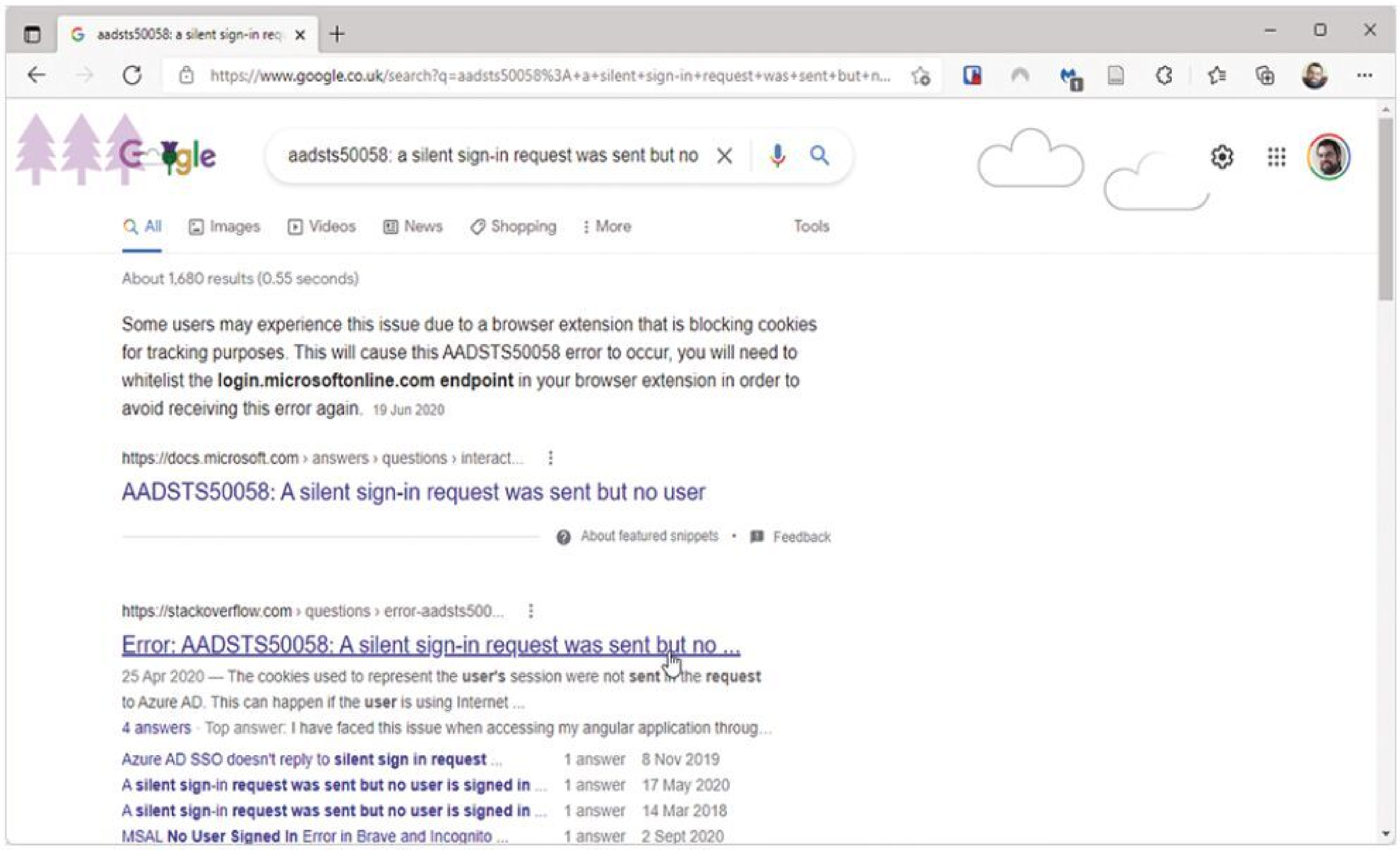


```
NICK-PC
  Central Processor(s)
  Motherboard
  Memory
  Bus
  Video Adapter
  Monitor
  Drives
  Audio
  Network
  Ports
    Serial Ports
    USB
      NVIDIA USB 3.10 eXtensible Host Controller - 1.10 (Microsoft)
      AMD USB 3.0 eXtensible Host Controller - 1.0 (Microsoft)
        Root Hub
          [Port1] : Generalplus Technology, PID=2002
          [Port2] : No Device Connected
          [Port3] : No Device Connected
          [Port4] : No Device Connected
          [Port5] : No Device Connected
          [Port6] : No Device Connected
          [Port7] : No Device Connected
          [Port8] : No Device Connected
      ASMedia USB 3.1 eXtensible Host Controller - 1.10 (Microsoft)
        Root Hub
          [Port1] : No Device Connected
          [Port2] : No Device Connected
          [Port3] : No Device Connected
          [Port4] : Lenovo, PID=FF50
      AMD USB 3.10 eXtensible Host Controller - 1.10 (Microsoft)
```

Feature	Description
Device Information	
Device Manufacturer:	GENERAL
Product Name:	GENERAL WEBCAM
Serial Number:	N/A
USB Version Supported:	2.00
USB Device Speed:	USB 2.0 High-speed
Driver Description:	USB Composite Device
Hardware ID:	USB\VID_1B3F&PID_2247
Driver Information	
Driver Manufacturer:	(Standard USB Host Controller)
Driver Description:	USB Composite Device
Driver Provider:	Microsoft
Driver Version:	10.0.22000.1
Driver Date:	21-Jun-2006
DeviceInstanceId	USB\VID_1B3F&PID_2247\6&13250158&0&1
Location Paths	PCIROOT(0)#PCI(0701)#PCI(0003)#USBROOT(0)#USB(1)

NICK-PC -> Ports -> USB -> AMD USB 3.0 eXtensible Host Controller - 1.0 (Microsoft) -> Root Hub -> [Port1] : Generalplus Technology, PID=2002

HWiNFO can help identify potential conflicts between USB devices.


aadsts50058: a silent sign-in req
https://www.google.co.uk/search?q=aadsts50058%3A+a+silent+sign-in+request+was+sent+but+n...
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aadsts50058: a silent sign-in request was sent but no

About 1,680 results (0.55 seconds)

Some users may experience this issue due to a browser extension that is blocking cookies for tracking purposes. This will cause this AADSTS50058 error to occur, you will need to whitelist the **login.microsoftonline.com endpoint** in your browser extension in order to avoid receiving this error again. 19 Jun 2020

https://docs.microsoft.com › answers › questions › interact...

AADSTS50058: A silent sign-in request was sent but no user

https://stackoverflow.com › questions › error-aadsts500...

Error: AADSTS50058: A silent sign-in request was sent but no ...

25 Apr 2020 — The cookies used to represent the **user's** session were not **sent** to the **request** to Azure AD. This can happen if the **user** is using Internet ...

4 answers · Top answer: I have faced this issue when accessing my angular application throug...

Azure AD SSO doesn't reply to **silent sign in request** ...	1 answer	8 Nov 2019
A **silent sign-in request was sent but no user is signed in** ...	1 answer	17 May 2020
A **silent sign-in request was sent but no user is signed in** ...	1 answer	14 Mar 2018
MSAL **No User Signed In** Error in Brave and Incognito ...	1 answer	2 Sept 2020

You may have to phrase your search terms carefully to find any relevant fixes online.

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TROUBLESHOOT INDIVIDUAL UPDATES

Often, the problem isn't with Windows Update itself, but a specific update that refuses to install. You may get an advanced warning, such as a message during reboot that Windows is reversing a failed update, or your PC may keep attempting to install updates after every reboot. If the problem persists, it's time to take further action.

Check the status of updates via the Windows Update tool. Simply click 'View update history', where you'll see a list of previously installed updates and whether they were successful or not. If multiple updates are failing, then it's likely only one of them is the culprit.

Start by trying to download and install the troublesome update manually. Go to www.catalog.update.microsoft.com and search for the update number (including KB). You'll be given a list of matches based on Windows version, plus system architecture—x64 is for 64-bit versions of Windows, x86 for 32-bit. Download the file to your hard drive, then double-click it and follow the instructions to install it.

If this doesn't work, you'll need to dig deeper. Make a careful note of the error code and the updated KB number. Google the code, try it with "Windows Update", your version of Windows, the KB number, or just on its own to see what you find. Ignore ads and focus on genuine websites, including reputable sources such as https://answers.microsoft.com. Focus on newer results first, particularly if they correspond to your specific KB number.

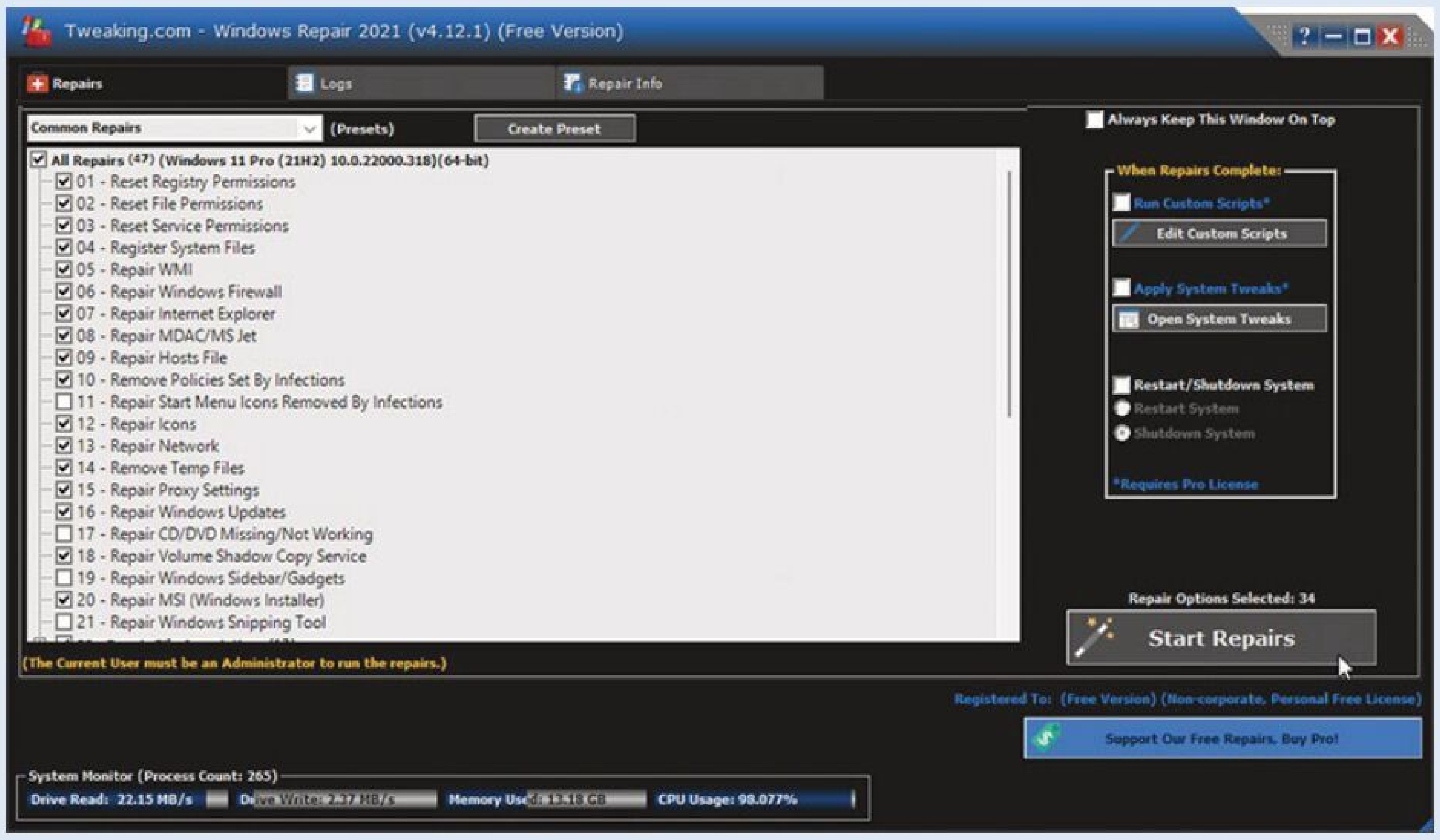
With a bit of luck, you'll stumble on a solution found by others. Often, there's no rhyme or reason to certain updates failing, but if all of the troubleshooting techniques we have described here, including the Windows Repair tool, fail to yield a solution, don't panic. Simply ping the Doctor an email and he'll see if he can steer you towards the solution.

FILE EXPLORER GLITCHES

Problems with File Explorer, particularly where it stops responding or takes an age to open certain folders (or indeed any folder), could mean any number of things. Start your focus on the health of your hard drives, use a tool such as HDDScan (https://hddscan.com/) to give them the once over physically, then schedule disk checks from an administrative command prompt:

```
chkdsk c: /f/r
```

When checking your system drive, you'll be prompted to schedule the check after the next reboot. Do so, reboot and


Tweaking.com - Windows Repair 2021 (v4.12.1) (Free Version)
Repairs
Logs
Repair Info
Create Preset
Edit Custom Scripts
Open System Tweaks
Start Repairs
Support Our Free Repairs, Buy Pro!

Common Repairs (Presets)

- ☑ All Repairs (47) (Windows 11 Pro (21H2) 10.0.22000.318)(64-bit)
  - ☑ 01 - Reset Registry Permissions
  - ☑ 02 - Reset File Permissions
  - ☑ 03 - Reset Service Permissions
  - ☑ 04 - Register System Files
  - ☑ 05 - Repair WMI
  - ☑ 06 - Repair Windows Firewall
  - ☑ 07 - Repair Internet Explorer
  - ☑ 08 - Repair MDAC/MS Jet
  - ☑ 09 - Repair Hosts File
  - ☑ 10 - Remove Policies Set By Infections
  - ☐ 11 - Repair Start Menu Icons Removed By Infections
  - ☑ 12 - Repair Icons
  - ☑ 13 - Repair Network
  - ☑ 14 - Remove Temp Files
  - ☑ 15 - Repair Proxy Settings
  - ☑ 16 - Repair Windows Updates
  - ☐ 17 - Repair CD/DVD Missing/Not Working
  - ☑ 18 - Repair Volume Shadow Copy Service
  - ☐ 19 - Repair Windows Sidebar/Gadgets
  - ☑ 20 - Repair MSI (Windows Installer)
  - ☐ 21 - Repair Windows Snipping Tool

(The Current User must be an Administrator to run the repairs.)

☐ Always Keep This Window On Top

When Repairs Complete:

☐ Run Custom Scripts*

☐ Apply System Tweaks*

☐ Restart/Shutdown System

○ Restart System

○ Shutdown System

*Requires Pro License

Repair Options Selected: 34

Registered To: (Free Version) (Non-corporate, Personal Free License)

System Monitor (Process Count: 265)

Drive Read: 22.15 MB/s Drive Write: 2.37 MB/s Memory Used: 13.18 GB CPU Usage: 98.077%

ONE-STOP FIXIT TOOL

Looking for a tool that provides access to dozens of fixes for common Windows problems? Go to www.tweaking.com and download the free version of Windows Repair Tool.

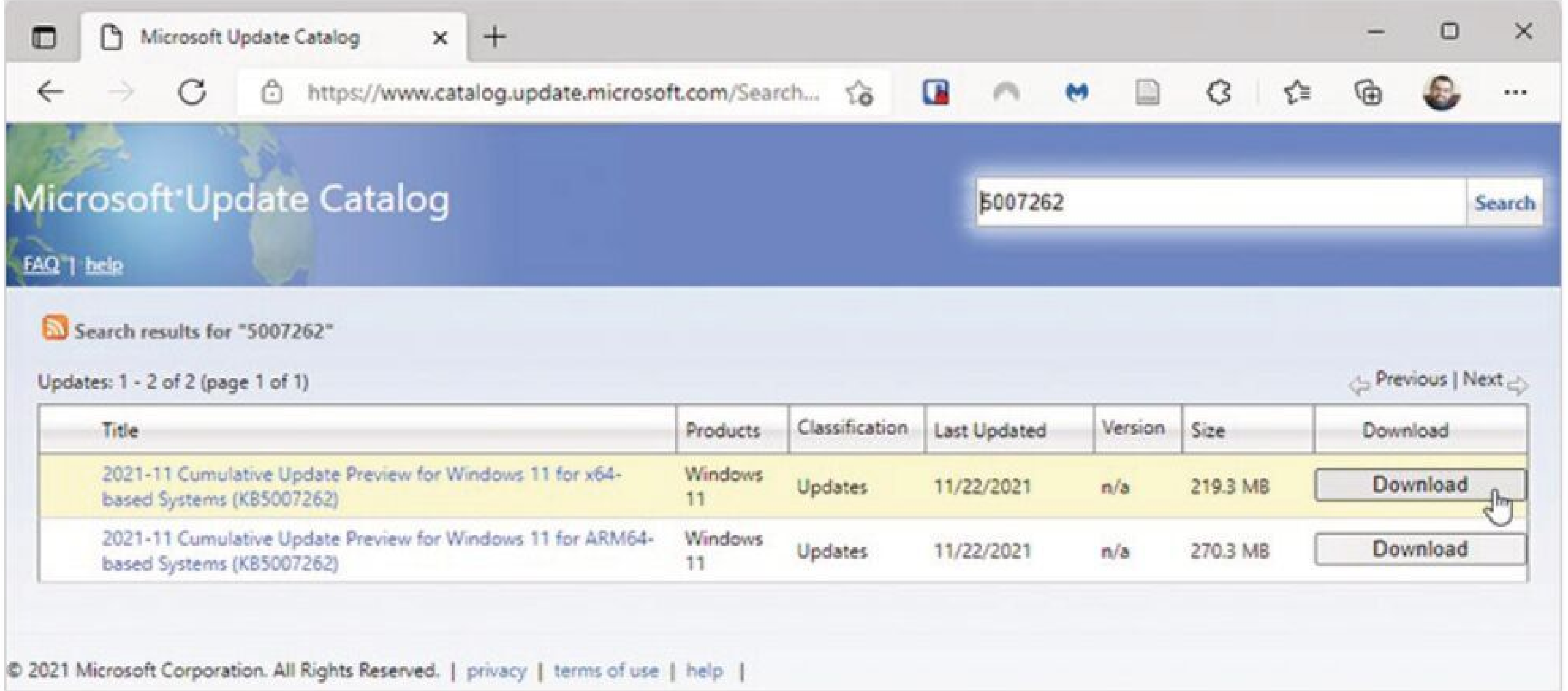
WRT runs best in Safe mode—the quickest way to get there is to press Win + R, type msconfig then hit Enter, then switch to the Boot tab, tick 'Safe boot', and select Network. Click OK followed by Restart, and Windows will reboot into Safe mode (you'll need to log in with your full password, not a PIN number or other form of ID). Once logged in, launch the Windows Repair Tool.

After the program has performed its start-up check, click 'I Agree' to go to the main screen. Work your way through various health checks, a power reset, plus scans of your Windows package files, system reparse points, and environment variables (you can ignore issues with reparse points, so skip the repair option).

There are also options to run full disk checks and a system file check—both are recommended. Reboot whenever prompted and you'll come back to Safe mode to carry on where you left off.

Once the basic tests are complete, select Backup Tools and take both a Registry backup and a System Restore point. Now select the 'Repairs—Main' tab to view the choices. Five presets exist to perform specific repairs. Click any option and you'll be shown a list of repairs with descriptive names like 'repair icons' or 'reset file permissions'. Use the Repair Info to find out more about individual repairs.

Select ones you think are applicable, then click Start Repairs. After you've (hopefully) fixed your problems, open msconfig again, and untick 'Safe boot' under the Boot tab to allow you to reboot into Windows proper to verify things are working correctly.



5007262

Search results for "5007262"

Updates: 1 - 2 of 2 (page 1 of 1)

Title	Products	Classification	Last Updated	Version	Size	Download
2021-11 Cumulative Update Preview for Windows 11 for x64-based Systems (KB5007262)	Windows 11	Updates	11/22/2021	n/a	219.3 MB	Download
2021-11 Cumulative Update Preview for Windows 11 for ARM64-based Systems (KB5007262)	Windows 11	Updates	11/22/2021	n/a	270.3 MB	Download

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If automatic updates are an issue, you can try downloading troublesome ones manually.

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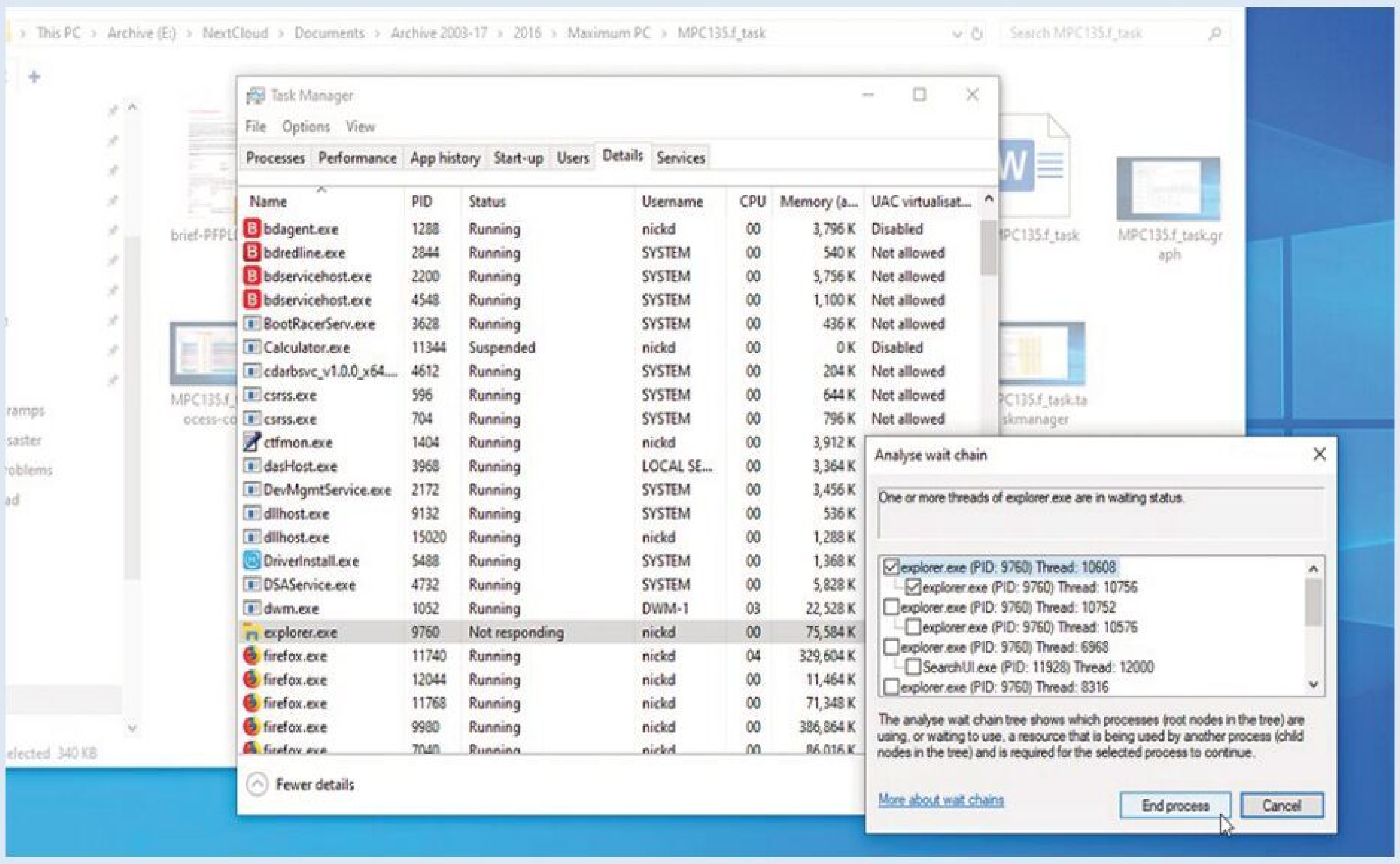
if you're lucky, errors will be found and repaired, and File Explorer will start working properly again.

If File Explorer 'resets' itself or stops responding when you right-click an item, then chances are the problem is with a third-party app that's tied itself into Explorer, for example, by adding items to the context menu that appears when you right-click a specific filetype or folder. If you recently installed a new app, focus on troubleshooting that with our guide below.

If you can't easily identify the app in question, look for a tool that can temporarily disable all third-party File Explorer plugins. One such example is ShellExView (www.nirsoft.net/utils/shexview.html), which we've successfully tested on Windows 11. Choose the 'Download ShellExView for x64' link, then unzip and run the program. Choose 'Options → Hide all Microsoft Extensions' to remove all but those plugins added by a third party, then you can go through the list looking for possible culprits. If all else fails, select all the items in the list, then press F7 to disable them all.

If the problem goes away, you know it's one of these items that's to blame. Re-enable them one at a time or in groups until the problem returns, and then deal with the offending item by leaving it disabled, checking for a program update to fix the issue, or removing the app entirely.


This PC > Archive (E:) > NextCloud > Documents > Archive 2003-17 > 2016 > Maximum PC > MPC135.f_task
Search MPC135.f_task
Task Manager
File Options View
Processes Performance App history Start-up Users Details Services
Fewer details

Name	PID	Status	Username	CPU	Memory (a...	UAC virtualisat...
bdagent.exe	1288	Running	nickd	00	3,796 K	Disabled
bdredline.exe	2844	Running	SYSTEM	00	540 K	Not allowed
bdservicehost.exe	2200	Running	SYSTEM	00	5,756 K	Not allowed
bdservicehost.exe	4548	Running	SYSTEM	00	1,100 K	Not allowed
BootRacerServ.exe	3628	Running	SYSTEM	00	436 K	Not allowed
Calculator.exe	11344	Suspended	nickd	00	0 K	Disabled
cdarbsvc_v1.0.0_x64....	4612	Running	SYSTEM	00	204 K	Not allowed
csrss.exe	596	Running	SYSTEM	00	644 K	Not allowed
csrss.exe	704	Running	SYSTEM	00	796 K	Not allowed
ctfmon.exe	1404	Running	nickd	00	3,912 K	
dasHost.exe	3968	Running	LOCAL SE...	00	3,364 K	
DevMgmtService.exe	2172	Running	SYSTEM	00	3,456 K	
dllhost.exe	9132	Running	SYSTEM	00	536 K	
dllhost.exe	15020	Running	nickd	00	1,288 K	
DriverInstall.exe	5488	Running	SYSTEM	00	1,368 K	
DSAService.exe	4732	Running	SYSTEM	00	5,828 K	
dwm.exe	1052	Running	DWM-1	03	22,528 K	
explorer.exe	9760	Not responding	nickd	00	75,584 K	
firefox.exe	11740	Running	nickd	04	329,604 K	
firefox.exe	12044	Running	nickd	00	11,464 K	
firefox.exe	11768	Running	nickd	00	71,348 K	
firefox.exe	9980	Running	nickd	00	386,864 K	
firefox.exe	7040	Running	nickd	00	86,016 K	

Analyse wait chain

One or more threads of explorer.exe are in waiting status.

- ☑ explorer.exe (PID: 9760) Thread: 10608
  - ☑ explorer.exe (PID: 9760) Thread: 10756
- ☐ explorer.exe (PID: 9760) Thread: 10752
  - ☐ explorer.exe (PID: 9760) Thread: 10576
- ☐ explorer.exe (PID: 9760) Thread: 6968
  - ☐ SearchUI.exe (PID: 11928) Thread: 12000
- ☐ explorer.exe (PID: 9760) Thread: 8316

The analyse wait chain tree shows which processes (root nodes in the tree) are using, or waiting to use, a resource that is being used by another process (child nodes in the tree) and is required for the selected process to continue.

TROUBLESHOOT FREEZES

There you are, clicking or typing away and things suddenly grind to a halt, the screen loses focus and the dreaded "not responding" message appears.

Step one is to be patient: if you have lots of programs running, then Windows can get in a temporary jam while it attempts to juggle resources. After a short period, things free themselves, at which point, you can save your file and continue.

But sometimes, the freeze doesn't end. If Windows hasn't already invited you to either close or restart the program, then try clicking its red close button once or twice. Again, be patient, but if nothing happens, try pressing Ctrl + Alt + Del and wait for the screen to blank before selecting Task Manager from the list of options.

When Task Manager appears, click More Details, if it's visible. Any non-responsive program should be highlighted—from here, you can attempt to close it by selecting the process and clicking the 'End task' button or, if you'd like to try and recover it, right-click it and choose 'Go to details'.

This will take you to the Details tab, where processes are listed with more information on their status (running or suspended), the user who launched them (typically you, SYSTEM, or a SERVICE), and a PID (Process ID).

Right-click the non-responding thread and choose 'Analyze wait chain'. This will list any threads that are using or waiting to use resources being used elsewhere, which can result in the program freezing. Clicking End Process here may be enough to free the program without crashing it, but be prepared for the entire program to close.

Sometimes Task Manager appears to have no effect. In these circumstances, you may be forced into a reboot. Before doing so, attempt to close all other programs and processes (including those running in the Taskbar Notification area) by normal means to minimize the damage and improve your chances of avoiding bigger problems.

DIG DEEPER

If none of the above techniques have helped you resolve your Windows problem, don't panic. Start by checking the box on the Tweaking.com Windows Repair tool, which offers fixes for a variety of problems. Other programs offering potential one-click fixes to many issues include FixWin10 (www.thewindowsclub.com/fixwin-for-windows-10) and Complete Internet Repair (www.rizonesoft.com/downloads/).

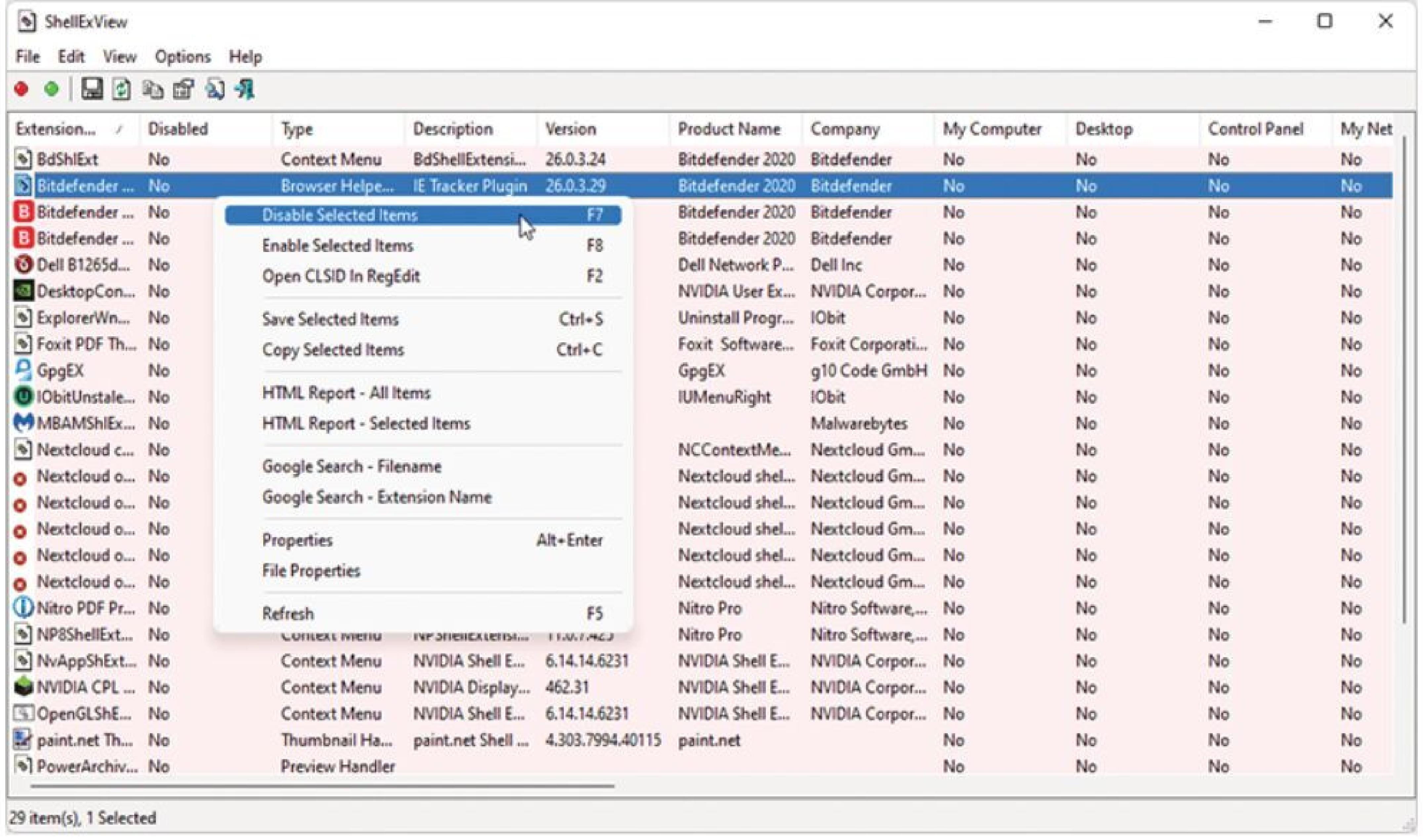
The art of troubleshooting problems is not about knowing that problem A is fixed by solution B but rather understanding the tools and techniques you need to find solution B. You'll not only acquire the knowledge required to understand which Windows tools will be of most use to any specific issue, but you'll also learn how to harness the power of the web to track down step-by-step solutions and remedies you can apply or adapt to your own circumstances.

GATHER PERTINENT INFORMATION

Step one involves diagnosing and describing the problem in such a way that you gain the information you need to go hunting for a solution if one doesn't present itself. The best problems to troubleshoot are those that can be linked to a specific program, have an obvious cause, and come with a detailed error message (including error code and filename). If you're lucky enough to get one of these, note down all the details and skip to the section on using the web.

Sadly, that's not always possible—you might be told that your program has encountered a problem and had to close, but nothing else is volunteered. Your PC might freeze for no apparent reason or throw up a blue screen error before restarting. These all indicate an underlying problem, but where do you go to find out more information?

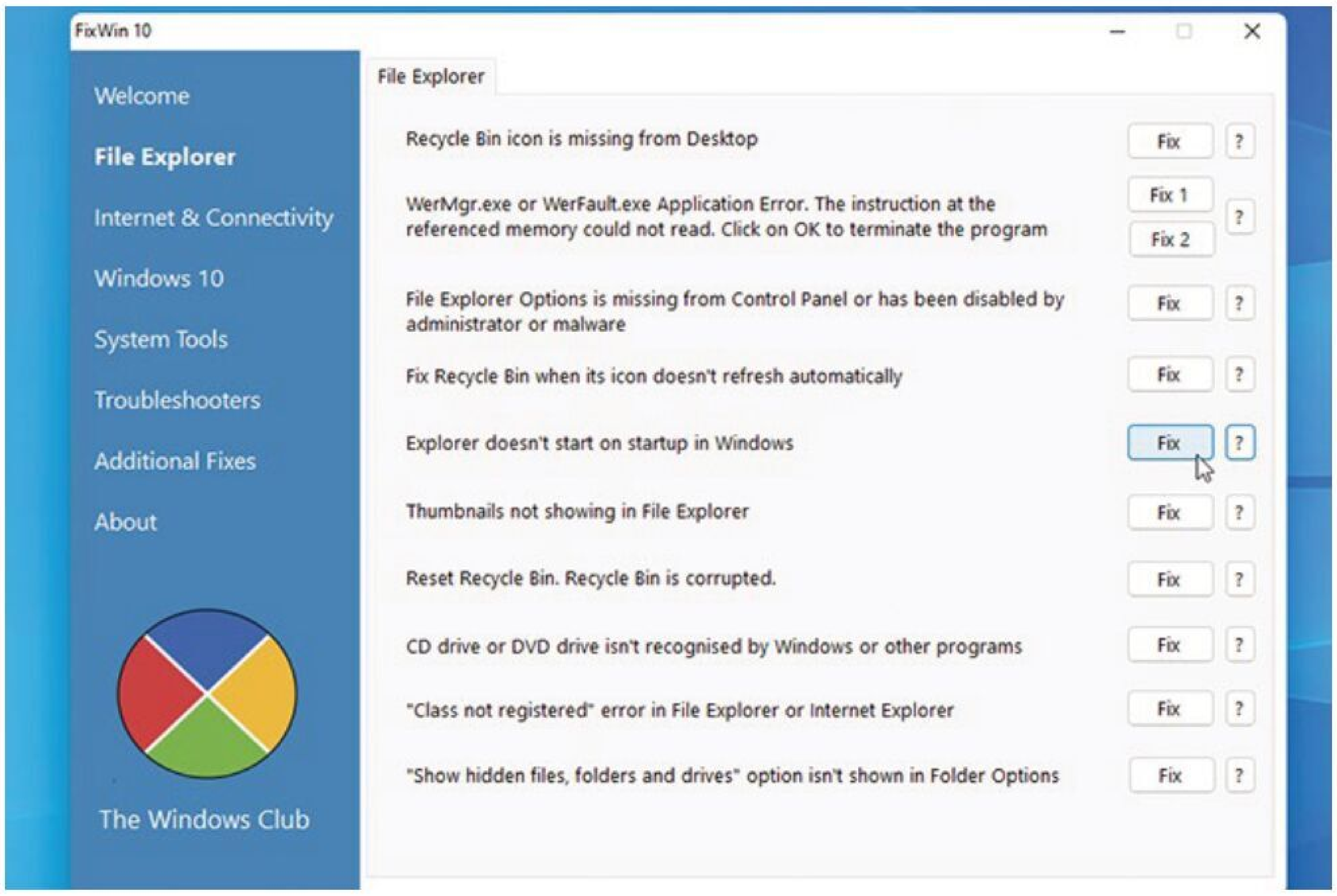
Windows records major events, including warnings and errors, in a series of logs. To access the relevant ones, type 'reliability' into the Search box and click 'View reliability history' to open the Reliability Monitor. You'll see a chart rating your PC for stability and providing a summary of failures (apps, Windows, and miscellaneous), warnings, and information. These provide a list of key events recorded. Make a note of the event, then click 'View technical details' to access information such as a program name, exception code, and type of error. Jot this down. If nothing is forthcoming, try widening your search to the entire log by right-clicking Start and choosing Event Viewer. Once it's loaded, expand the Critical Error and Warning sections to find log entries whose time stamps coincide with the problem you encountered.


ShellExView
File Edit View Options Help
Disable Selected Items F7
Enable Selected Items F8
Open CLSID In RegEdit F2
Save Selected Items Ctrl+S
Copy Selected Items Ctrl+C
HTML Report - All Items
HTML Report - Selected Items
Google Search - Filename
Google Search - Extension Name
Properties Alt+Enter
File Properties
Refresh F5

Extension...	Disabled	Type	Description	Version	Product Name	Company	My Computer	Desktop	Control Panel	My Net
BdShlExt	No	Context Menu	BdShellExtensi...	26.0.3.24	Bitdefender 2020	Bitdefender	No	No	No	No
Bitdefender ...	No	Browser Helpe...	IE Tracker Plugin	26.0.3.29	Bitdefender 2020	Bitdefender	No	No	No	No
Bitdefender ...	No				Bitdefender 2020	Bitdefender	No	No	No	No
Bitdefender ...	No				Bitdefender 2020	Bitdefender	No	No	No	No
Dell B1265d...	No				Dell Network P...	Dell Inc	No	No	No	No
DesktopCon...	No				NVIDIA User Ex...	NVIDIA Corpor...	No	No	No	No
ExplorerWn...	No				Uninstall Progr...	IObit	No	No	No	No
Foxit PDF Th...	No				Foxit Software...	Foxit Corporati...	No	No	No	No
GpgEX	No				GpgEX	g10 Code GmbH	No	No	No	No
IObitUnstale...	No				IUMenuRight	IObit	No	No	No	No
MBAMShlEx...	No					Malwarebytes	No	No	No	No
Nextcloud c...	No				NCContextMe...	Nextcloud Gm...	No	No	No	No
Nextcloud o...	No				Nextcloud shel...	Nextcloud Gm...	No	No	No	No
Nextcloud o...	No				Nextcloud shel...	Nextcloud Gm...	No	No	No	No
Nextcloud o...	No				Nextcloud shel...	Nextcloud Gm...	No	No	No	No
Nextcloud o...	No				Nextcloud shel...	Nextcloud Gm...	No	No	No	No
Nextcloud o...	No				Nextcloud shel...	Nextcloud Gm...	No	No	No	No
Nitro PDF Pr...	No				Nitro Pro	Nitro Software,...	No	No	No	No
NP8ShellExt...	No	Context Menu	NPShellExtensi...	11.0.7.425	Nitro Pro	Nitro Software,...	No	No	No	No
NvAppShExt...	No	Context Menu	NVIDIA Shell E...	6.14.14.6231	NVIDIA Shell E...	NVIDIA Corpor...	No	No	No	No
NVIDIA CPL ...	No	Context Menu	NVIDIA Display...	462.31	NVIDIA Shell E...	NVIDIA Corpor...	No	No	No	No
OpenGLShE...	No	Context Menu	NVIDIA Shell E...	6.14.14.6231	NVIDIA Shell E...	NVIDIA Corpor...	No	No	No	No
paint.net Th...	No	Thumbnail Ha...	paint.net Shell ...	4.303.7994.40115	paint.net		No	No	No	No
PowerArchiv...	No	Preview Handler					No	No	No	No

29 item(s), 1 Selected

Use ShellExView to disable third-party File Explorer plugins while you identify the culprit.


FixWin 10
Welcome
File Explorer
Internet & Connectivity
Windows 10
System Tools
Troubleshooters
Additional Fixes
About
The Windows Club
Fix
Fix 1
Fix 2
?

File Explorer

- Recycle Bin icon is missing from Desktop
- WerMgr.exe or WerFault.exe Application Error. The instruction at the referenced memory could not read. Click on OK to terminate the program
- File Explorer Options is missing from Control Panel or has been disabled by administrator or malware
- Fix Recycle Bin when its icon doesn't refresh automatically
- Explorer doesn't start on startup in Windows
- Thumbnails not showing in File Explorer
- Reset Recycle Bin. Recycle Bin is corrupted.
- CD drive or DVD drive isn't recognised by Windows or other programs
- "Class not registered" error in File Explorer or Internet Explorer
- "Show hidden files, folders and drives" option isn't shown in Folder Options

If it's Windows 10 you're struggling with, take a look at FixWin10.

SEARCH THE WEB

Your obvious first port of call for a solution is Microsoft Support (https://support.microsoft.com/en-us) or the website of the program or hardware device that's causing you grief. If this yields nothing, expand your search to Google.

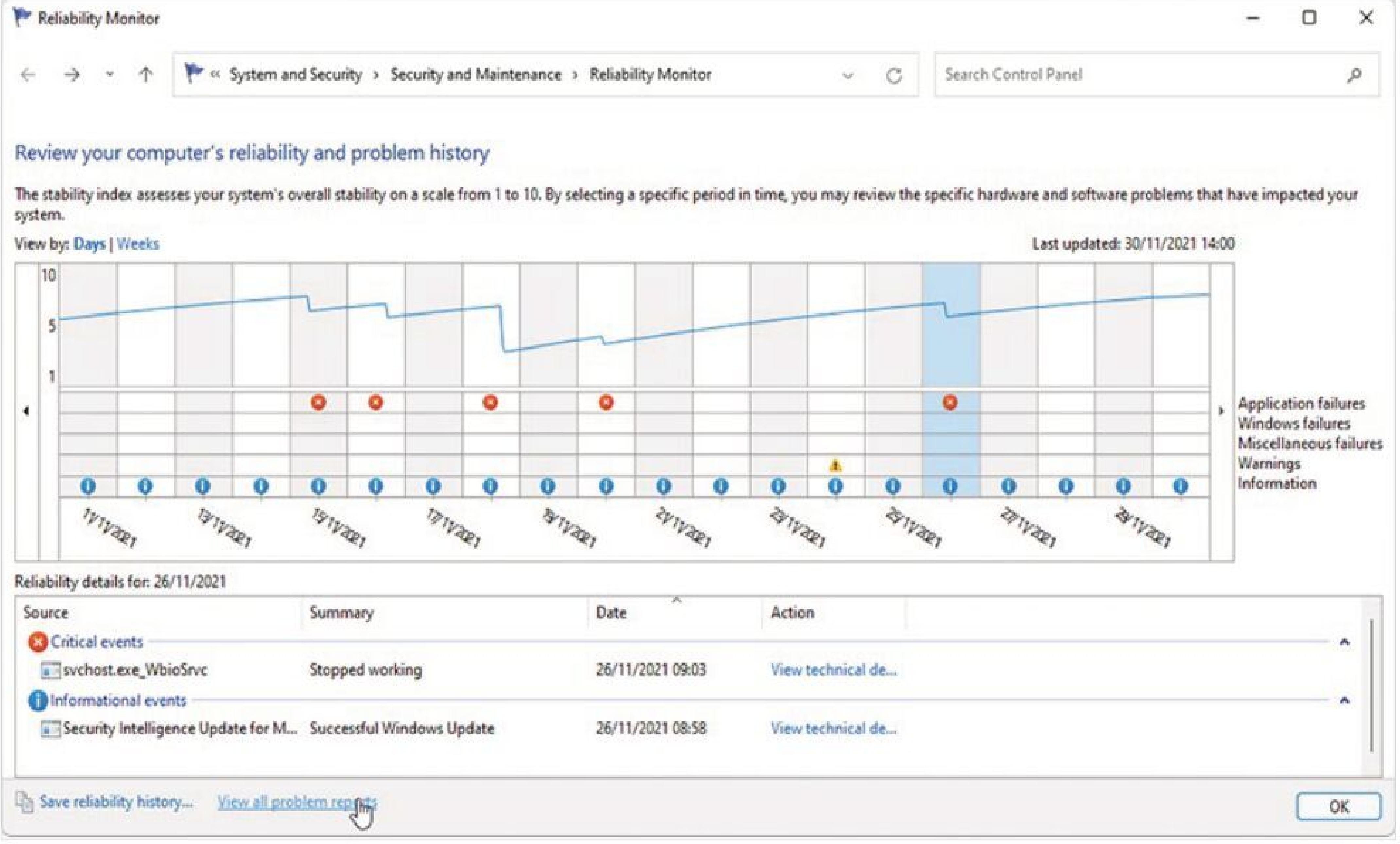
When searching the web for a solution to your problem, the key to finding potential fixes is knowing what words to include in your searches. Enter too many search terms and you'll get no results; enter too few and you'll find hundreds of results, most of which won't be relevant to your particular problem.

Rather than wade through these results, it makes sense to refine your search to see if you can narrow down the search results without missing out on potentially useful sites. Try entering words that are related to your problem: error messages, program names, the version number of Windows 10 such as 21H2, hardware, anything you think is relevant. When entering filenames or error codes, make sure you enter them exactly as they appeared on-screen. A frequent mistake is to type the letter O instead of the number 0 (zero).

Don't assume the first search results displayed are necessarily most relevant to your problem. Be prepared to scroll through a number of pages clicking promising links before deciding whether to refine your search terms further.

If you've pared your keywords down to the bare minimum in order to get a meaningful number of hits, but are still having no luck finding a solution, consider adding other possible relevant keywords to your search terms. If your problem is sound-related, for instance, including the name of your audio device might help you target a solution quicker.

Use Device Manager or HWiNFO to identify model names and drivers in case it's relevant, while program version numbers can be gleaned from Settings → Apps (click an entry to reveal its exact version number).


Reliability Monitor
System and Security › Security and Maintenance › Reliability Monitor
Search Control Panel
10
5
1
Application failures
Windows failures
Miscellaneous failures
Warnings
Information
11/11/2021
13/11/2021
15/11/2021
17/11/2021
19/11/2021
21/11/2021
23/11/2021
25/11/2021
27/11/2021
29/11/2021
Save reliability history...
View all problem reports
OK

Review your computer's reliability and problem history

The stability index assesses your system's overall stability on a scale from 1 to 10. By selecting a specific period in time, you may review the specific hardware and software problems that have impacted your system.

View by: Days | Weeks

Last updated: 30/11/2021 14:00

Reliability details for: 26/11/2021

Source	Summary	Date	Action
Critical events			
svchost.exe_WbioSrvc	Stopped working	26/11/2021 09:03	View technical de...
Informational events			
Security Intelligence Update for M...	Successful Windows Update	26/11/2021 08:58	View technical de...

The Reliability Monitor will give you an idea of past problems. It still works in Windows 11.

© MICROSOFT

CENTERFOLD

PERFORMANCE GEAR LAID BARE

Noblechairs EPIC Copper Limited Edition

UNLESS YOU HAVE ONE of those fancy lifting electric desks, adding a chair to your setup is a necessity. It's scary to think about how much of your week you spend sitting down. Whether that's at your workplace or your home, or both, the bottom line is that we spend huge chunks of our day sitting on a chair, so it makes sense to care for your rear and treat it to a nice place to rest.

Noblechairs is no stranger to providing quality seating solutions for many setups over the years. The company's range includes the Epic, Epic Compact, Hero, and Icon series chairs, each offering different characteristics and sizes. The one we are trying out here is the rather tasty limited edition Epic series chair. Style and design are subjective, but the Epic style is a timeless look inspired by the automotive world and it gets a thumbs up from us here at *Maximum PC*.

It is supportive and endlessly adjustable to provide comfort throughout the day. This is the Copper edition, featuring subtle touches of the color throughout the design creating a more premium aesthetic. –SAM LEWIS

1 COPPER MAKES CENTS

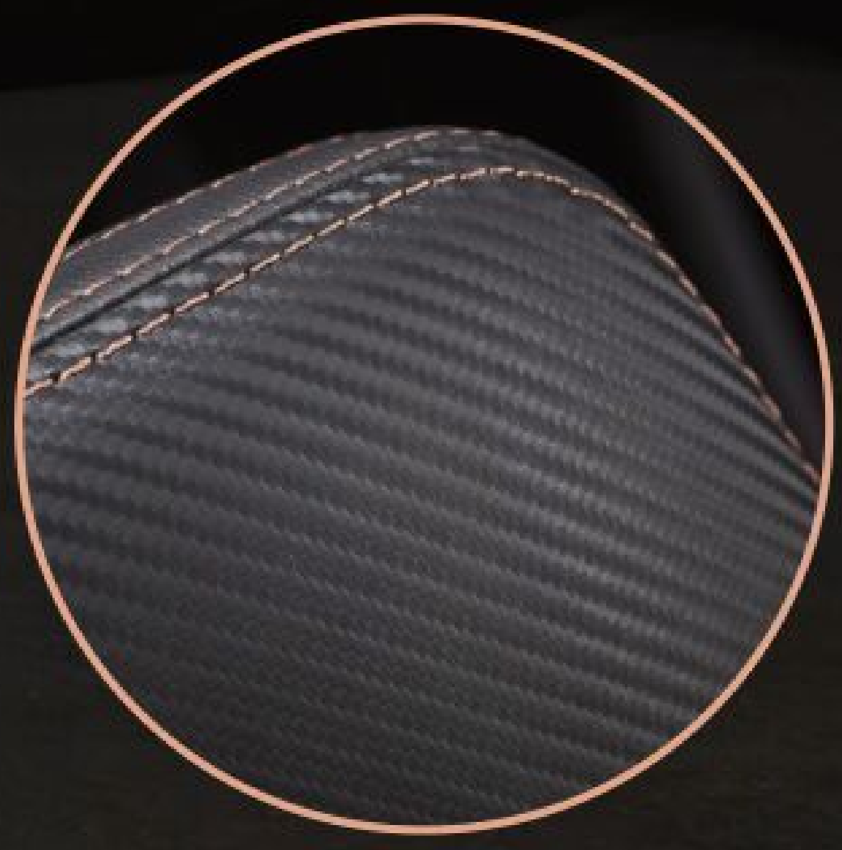
There are plenty of color schemes that look mediocre at best, however, we love this one. The copper paired with black hints at a more premium look while still keeping that traditional gaming chair design. Noblechairs has accented the color enough in places such as the racing harnesses, logos, the armrest, and the stitching throughout. In certain lighting, the copper is almost rose gold but, either way, we like it.

2 QUALITY MATERIALS

A choice of materials allows you to add some nice finishing touches. Noblechairs has a range to choose from if you are creating your own, but we wouldn't swap out anything on this EPIC Copper Edition. The overall material is a vegan PU leather that feels soft to the touch and is comfortable for lengthy use. The seat is the same material, but perforated to help with durability and cooling, and everything feels durable and premium.

3 THE RACING LINE

The overall shape of the chair may have been inspired by the automotive world, but there is another part of the design that car enthusiasts will enjoy. The back and sides of the chair feature a carbon fiber effect weave, reminiscent of those in racing car seats. This reduces the overall weight and keeps the driver supported when hitting the apex. Though we would have loved to see actual carbon fiber here, it would have added to the price.



Special Premiere Collector's Edition!
boot
PURE PC POWER
First Look! 200MHz Monster Systems With Onboard 3D
Interview: Bill Gates Gets Serious About Games
How-to Weave a Personal Web Page With Panache
Rendering on the Fly: The Future of Flight Sims
WARNING THIS MAGAZINE MAY TURN YOUR LOVE OF PCs INTO AN OBSESSION
DREAM MACHINE
We'll Show You How To Build Your Own Perfect $5K PC
also: Over 40 Hardware and Software Releases Previewed and Reviewed
$7.99 U.S. $8.99 CAN. 09
imagine
MAXIMUM PC
BIOS SECRETS REVEALED!
DIGI-CAM FACEOFF!
DELL SCREAMS AT 2.4GHz
PC HOME STEREO?
LOST WEAPONS OF 3DFX
AMAZING BUT TRUE!
BEST POCKET PC EVER
MULTI-BOOT MANIA!
EXCLUSIVE AMD STRIKES
WINDOWS 2000 ON TRIAL
WHAT'S BEHIND WINDOWS

THE BEST OF *MAXIMUM PC*

As *Maximum PC* heads into a new era, we reminisce about the origins of our favorite magazine and how far the PC itself has come in that time…

96
01
otnet.com

The first issue of *Boot* in August 1996, which would be renamed *Maximum PC* a few years later.

MAXIMUMPC
2022
TECH
PREVIEW

NEARLY 300 ISSUES OF PURE, PC-driven passion. That's the landmark we are approaching as *Maximum PC* prepares to reveal its new editor. You'll have to wait until next issue to find out more about that. But as the magazine heads into a new era with fresh leadership, now is a good time to look back on where it all began.

The first issue of *Maximum PC* was published in September 1998. But its real origins date back to August 1996 and the first issue of *Boot*, the magazine that would later become *Maximum PC*. It's no surprise to discover the first issue of *Boot* set the template in so many ways, leading with the "Dream Machine" cover. DIYing our own PC from hand-picked components was the way, the truth, and the light back in 1996. Not much has changed since. We still prefer to roll up our sleeves and short out some circuits than buy off-the-shelf. Something that has changed, however, is the hardware.

Take that 1996 Dream Machine's CPU. How about 200MHz worth of pure Pentium goodness? Yours for $495 (more like $850 in today's inflation-adjusted cash). Of course, back then you didn't just have Intel CPUs, but also AMD and Cyrix chips. Cyrix's 166MHz 686 processor was competitive, though AMD's 586 chip was a chump, more a tweaked 386/486 hybrid than a true 586 instruction set processor.

Here's the kicker, to go with the Pentium CPU, we recommended a motherboard with the VT82C580VP Apollo-VP chipset, adding a cool $1,000 (call it $1,750 today). Suddenly, current chip-shortage component prices don't look quite so bad. To that, add $400 for 32MB of DRAM and a piffling $350 for a video card. As for the latter, that bought you a Matrox Millenium with a mighty 4MB of WRAM (yes, WRAM) in PCI format and with full DirectX support, That's just simple DirectX, back when the idea of a multimedia API in Windows was novel.

Screen-wise, our choice was a 17-inch, glass-tubed, Trinitron-based Eizo Nanao T2-17TS. With a maximum resolution of 1,250x938, it cost a wallet-wilting $1,000. For storage, we plumped for a $400 SCSI card and a Quantum Atlas 2.1GB HDD. Get a load of 2.1GB mass storage! Chuck in a CD-ROM and a Zip drive, for about 200 bucks each, plus a $200 sound card, a $350 ISDN modem, plus keyboard, mouse, and speakers, not to mention a 300W power supply for $100 and a steel case with three 5.25-inch bays and a couple of 3.5-inch bays and you have what was then the ultimate PC for $5,000, or near enough double that in today's money.

It's intriguing to think what nearly $10,000 would buy you today and, indeed, just how outdated it will seem in another 25 years. While you ponder all that, why not enjoy some of our favorite covers from the last 200 issues of *Maximum PC* plus our take on the best builds and Dream Machines over the years.

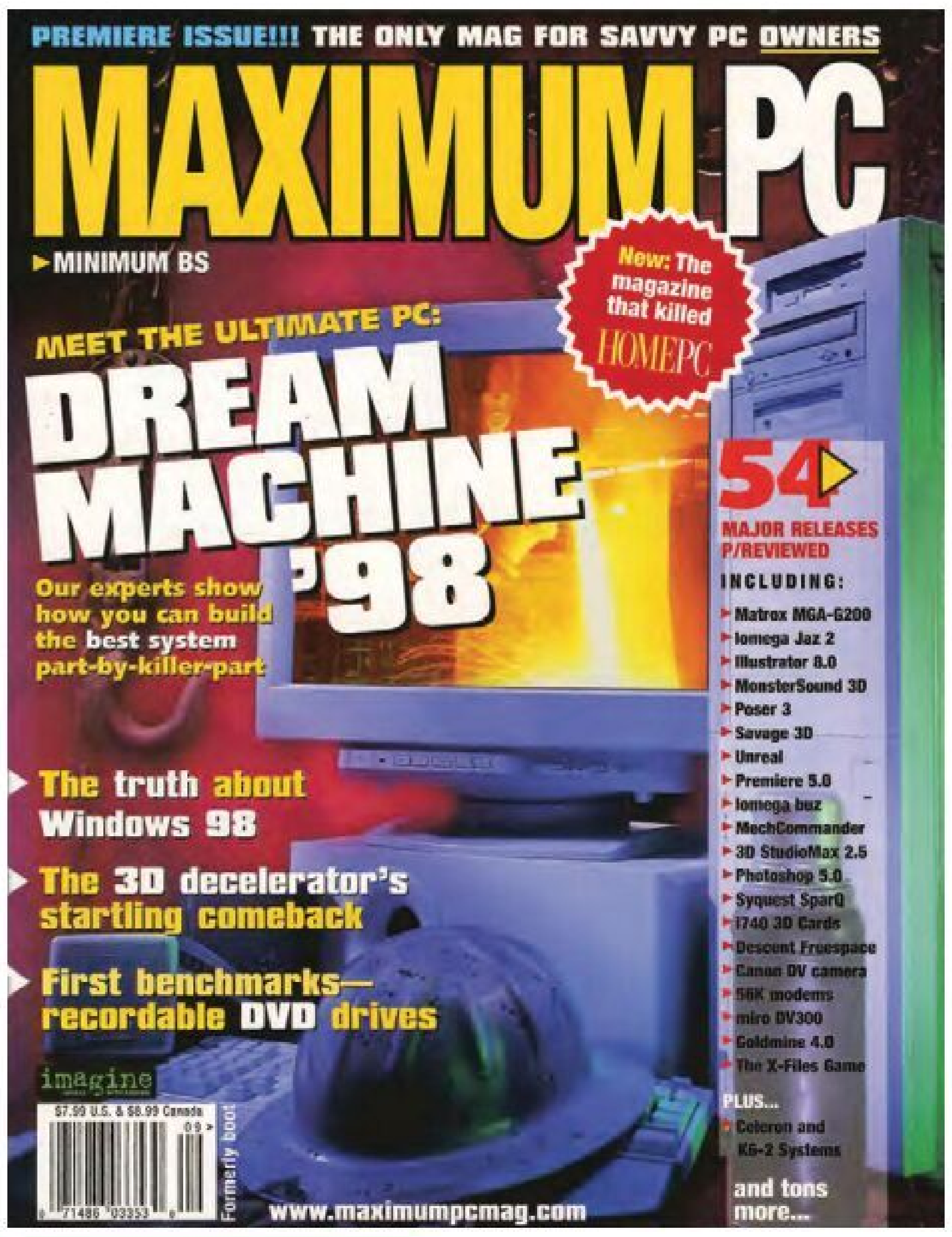
SIMPLY THE BEST

With nearly 300 issues to choose from, here's our pick of the best *Maximum PC* covers from over the years

IT ALL STARTED WITH "Dream Machine", on both the cover of the first issue of *Maximum PC* and its progenitor, *Boot* magazine. Over the years, megabucks Dream Machines have been just one of several signature cover features. Other regulars include "Gear of the Year', "Tech Preview" and "Speed up Your PC". Head-to-heads pitching Intel against its rival AMD have been popular down the years, as have features celebrating or denigrating the arrival of a new version of the 800lb gorilla of operating systems, Microsoft Windows. We've enjoyed giving Microsoft a kicking now and then.

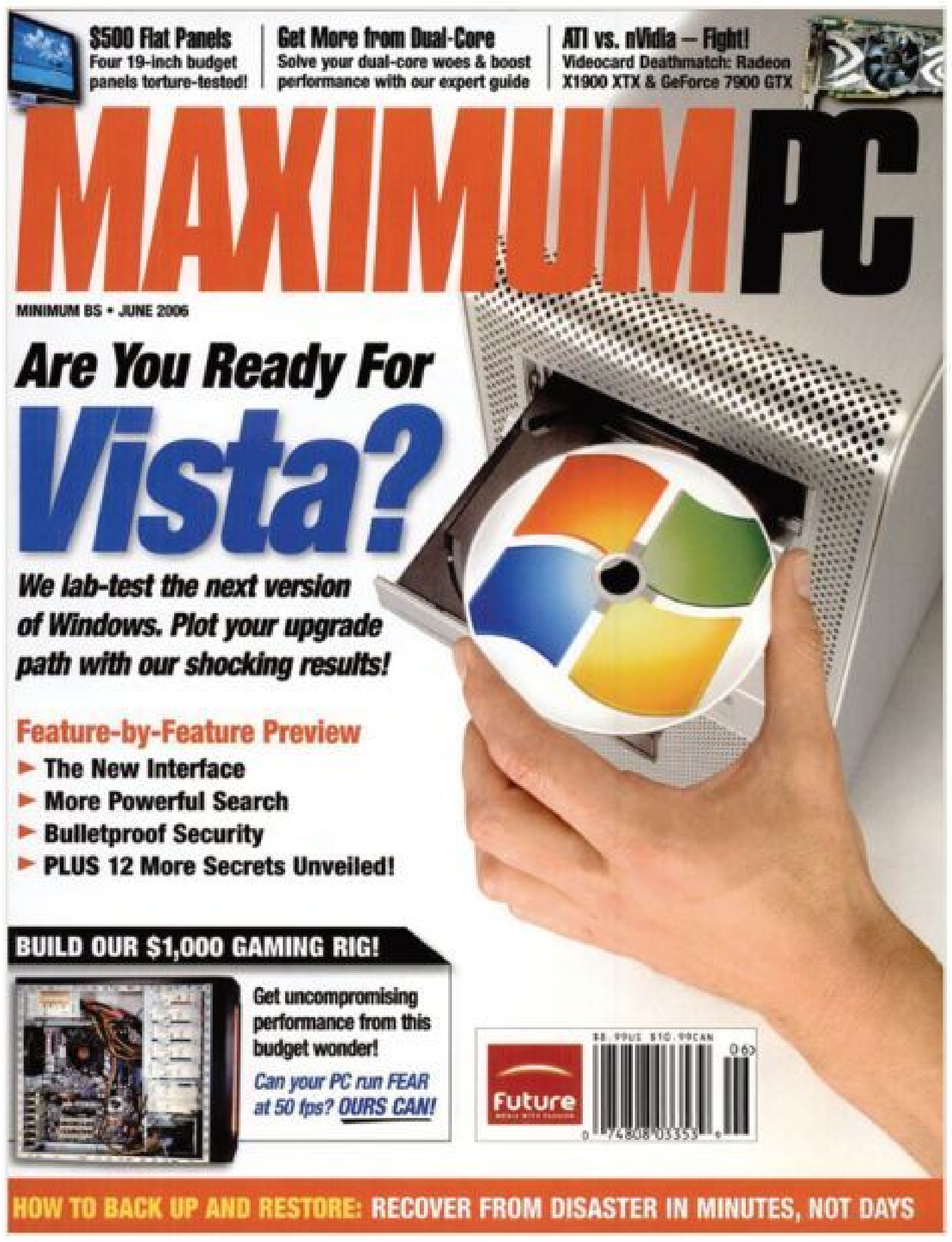
Of course, "Build It" covers of all flavors represent the beating heart of the magazine, covering a huge array of remits, from sub $300 budget rigs to special-purpose PCs for everything from rendering to gaming and music production. It's fun to see how the magazine's look has evolved over the years. The early days were high impact but, let's face it, low production values.

What's intriguing is just how quickly *Maximum PC* settled on a look that really worked. Following the late 1998 rebrand from *Boot* to *Maximum PC*, by 2001 the magazine had settled on the italicized masthead and cover layout that still survives today. Just a few years after that, the internal design of the magazine and details such as fonts had been honed into pretty much the same, polished, slick printed product you see today.


PREMIERE ISSUE!!! THE ONLY MAG FOR SAVVY PC OWNERS
MAXIMUM PC
MINIMUM BS
New: The magazine that killed HOMEPC
MEET THE ULTIMATE PC: DREAM MACHINE '98
Our experts show how you can build the best system part-by-killer-part
54 MAJOR RELEASES P/REVIEWED
The truth about Windows 98
The 3D decelerator's startling comeback
First benchmarks—recordable DVD drives
www.maximumpcmag.com

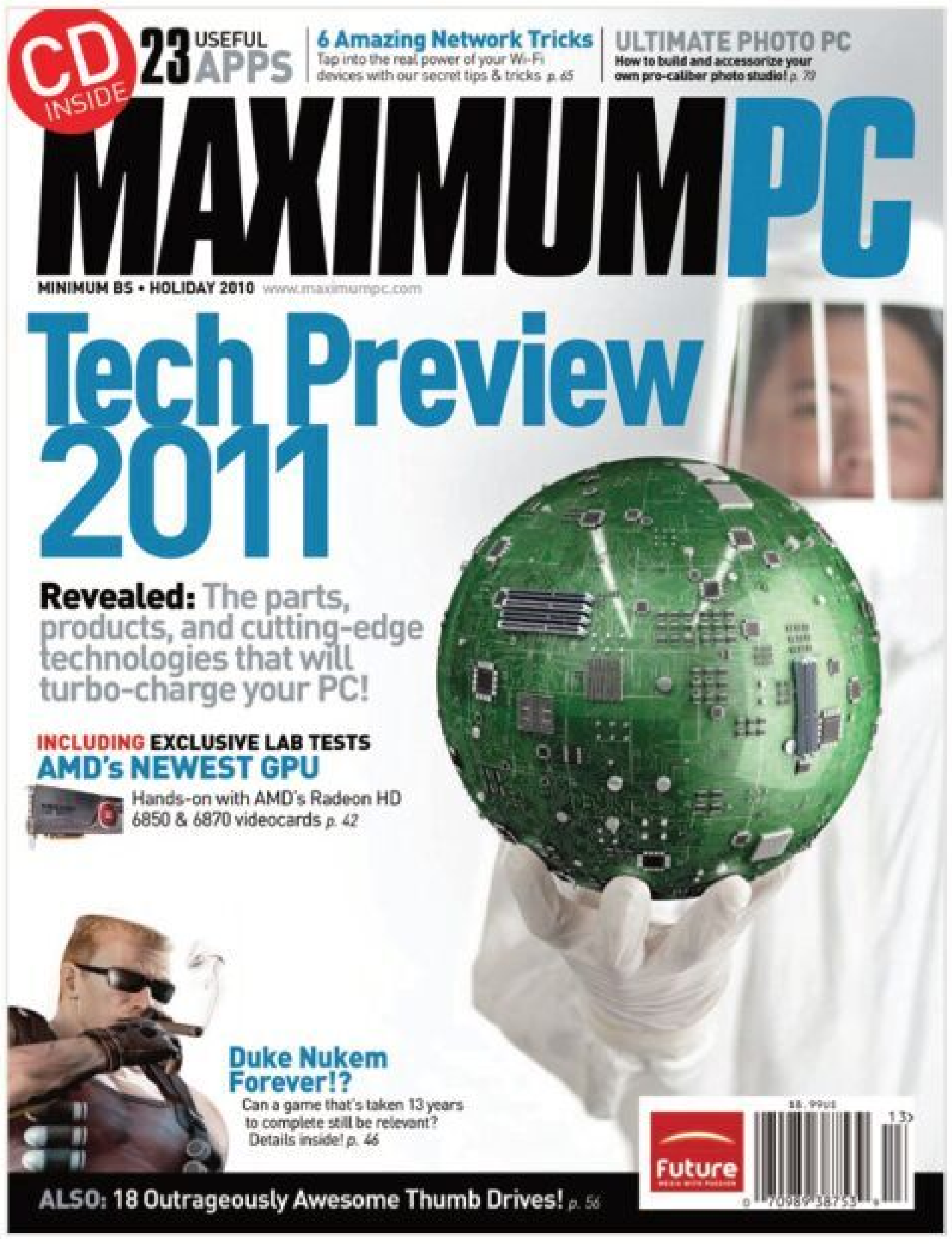
SEPTEMBER 1998

It ain't exactly pretty, but it is the very first issue of *Maximum PC*. Issue 001 showcases a "Dream Machine" up front and center and also touches on Windows 98 as the OS du jour. Our coverage of the "first benchmarks" of recordable DVD drives is a reminder of just how cheap and convenient external storage has now become. Imagine having to burn data to disc, now that thumb drives with 10s of gigabytes of capacity are almost free!


$500 Flat Panels
Get More from Dual-Core
ATI vs. nVidia – Fight!
MAXIMUM PC
MINIMUM BS • JUNE 2006
Are You Ready For Vista?
We lab-test the next version of Windows. Plot your upgrade path with our shocking results!
Feature-by-Feature Preview
The New Interface
More Powerful Search
Bulletproof Security
PLUS 12 More Secrets Unveiled!
BUILD OUR $1,000 GAMING RIG!
HOW TO BACK UP AND RESTORE: RECOVER FROM DISASTER IN MINUTES, NOT DAYS

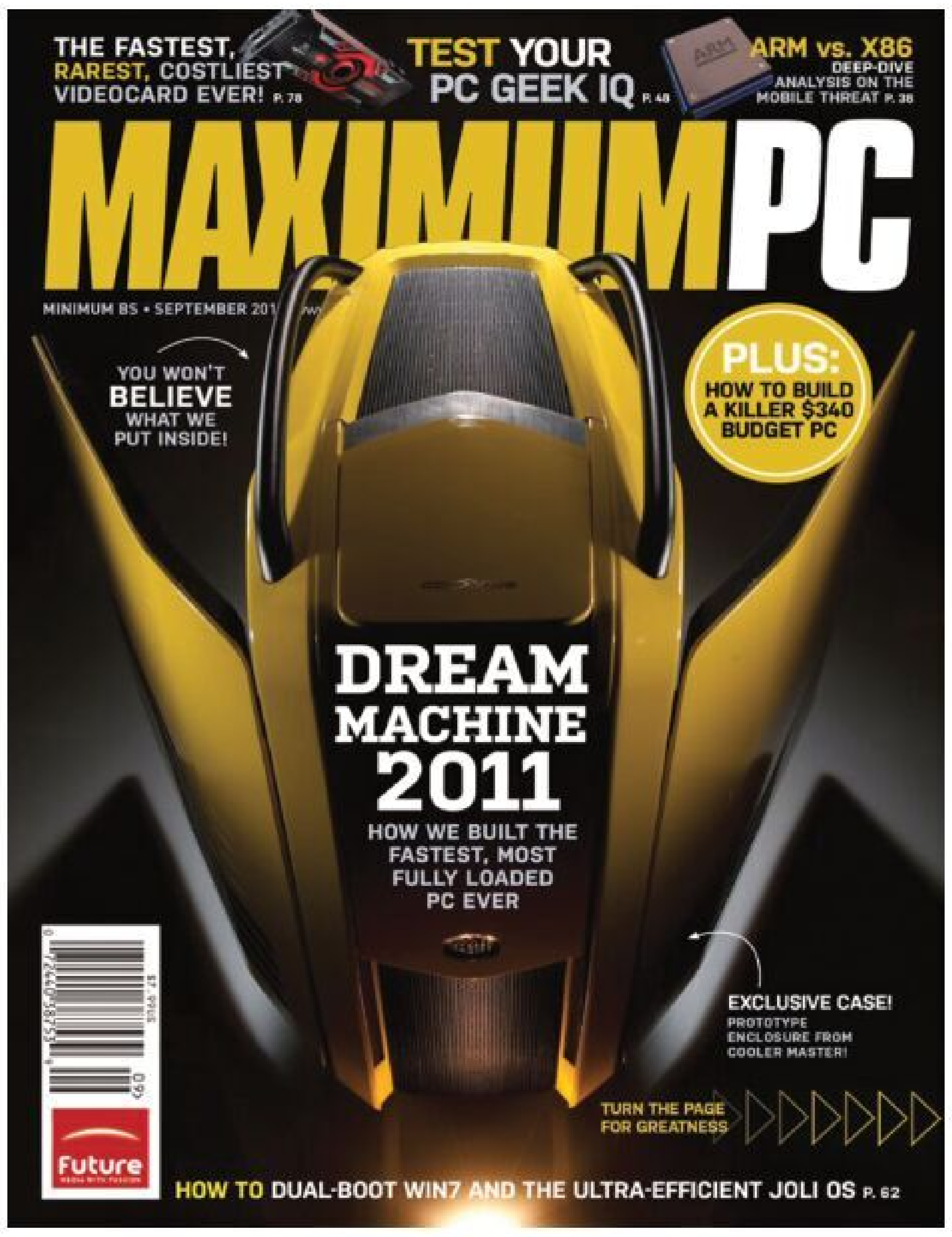
JUNE 2006

As Windows 11 rolls out, June 2006 offers a reminder of the pitfalls of new builds of Microsoft's ubiquitous OS. We sampled a beta version of Vista and found it lacking. Vista was arguably the first modern Windows, complete with 3D accelerated GUI, advanced power management, new networking subsystem, and more. But after testing, editor Will Smith was underwhelmed. Hardly a first for a new version of Windows and far from the last.


CD INSIDE
23 USEFUL APPS
6 Amazing Network Tricks
ULTIMATE PHOTO PC
MAXIMUM PC
MINIMUM BS • HOLIDAY 2010
Tech Preview 2011
Revealed: The parts, products, and cutting-edge technologies that will turbo-charge your PC!
INCLUDING EXCLUSIVE LAB TESTS AMD's NEWEST GPU
Duke Nukem Forever!?
ALSO: 18 Outrageously Awesome Thumb Drives!

HOLIDAY 2010

No PC-related compendium is complete without a reference to the game that dare not speak its name, *Duke Nukem Forever*. This issue appeared over 10 years ago when the game was already 13 years in the making. It eventually appeared in summer 2011 and is still listed on the Guinness World Records website as the longest development for a video game (14 years and 43 days). As it turned out, *Duke Nukem Forever* wasn't worth the wait.


THE FASTEST, RAREST, COSTLIEST VIDEOCARD EVER!
TEST YOUR PC GEEK IQ
ARM vs. X86
MAXIMUM PC
YOU WON'T BELIEVE WHAT WE PUT INSIDE!
PLUS: HOW TO BUILD A KILLER $340 BUDGET PC
DREAM MACHINE 2011
HOW WE BUILT THE FASTEST, MOST FULLY LOADED PC EVER
EXCLUSIVE CASE!
TURN THE PAGE FOR GREATNESS
HOW TO DUAL-BOOT WIN7 AND THE ULTRA-EFFICIENT JOLI OS

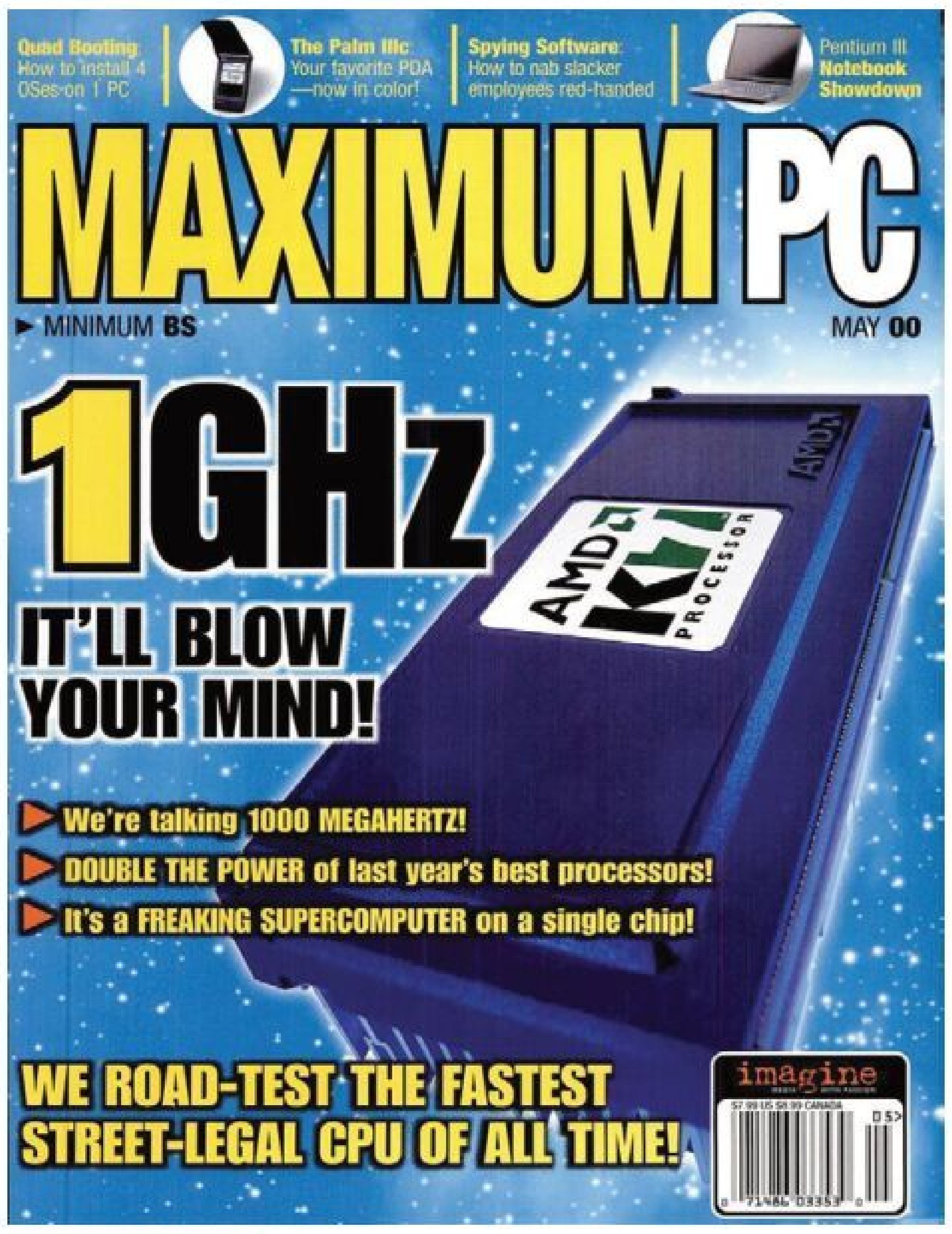
SEPTEMBER 2011

Don't judge a magazine by its cover? We are giving this issue the nod on looks alone. The killer bee vibe was courtesy of a then-prototype Coolermaster case that packed no fewer than three Nvidia GeForce GTX 580 graphics cards and an Intel Core i7-2600K chip running overclocked at 4.8GHz. Throw in a pair of 240GB SSDs, 16GB of RAM and you have a pretty beefy machine for $12,888, with three 30-inch monitors at $2,300 each.

MAXIMUM PC
PC'S THAT DON'T WIMP OUT
SEPTEMBER 99
DREAM MACHINE '99
BUILD IT
YOUR ULTIMATE PC IN 16 EASY STEPS
COMPLETE HOW-TO CONSTRUCTION GUIDE
PART-BY-PART BUYING TIPS
WHEN PRICE IS NO OBJECT: 12 EXTREME POWER PARTS

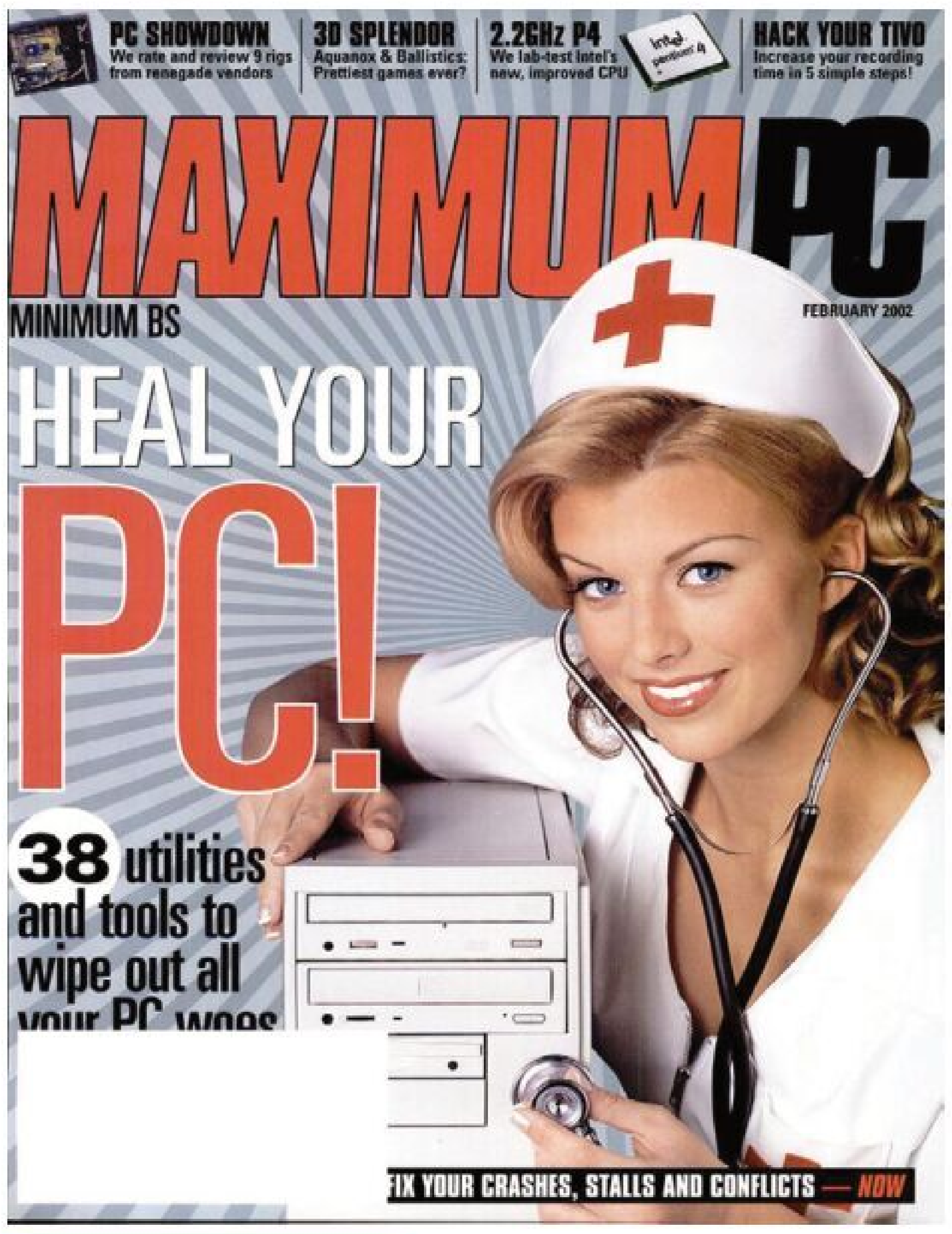
SEPTEMBER 1999

You've got to hand it to the boys back in the 90s, they knew how to have fun with the cover. Our 13th issue goes all-in on the Build It theme with a literal exposition of DIY prowess, courtesy of then-editor Brad Dosland. We also had our first look at the mighty Matrox G400 graphics card with two pixel pipelines and AMD's new K7 CPU, and wondered whether attempts to control MP3 piracy by the recording industry threatened to ruin the internet.


MAXIMUM PC
MINIMUM BS
MAY 00
1GHz
IT'LL BLOW YOUR MIND!
We're talking 1000 MEGAHERTZ!
DOUBLE THE POWER of last year's best processors!
It's a FREAKING SUPERCOMPUTER on a single chip!
WE ROAD-TEST THE FASTEST STREET-LEGAL CPU OF ALL TIME!

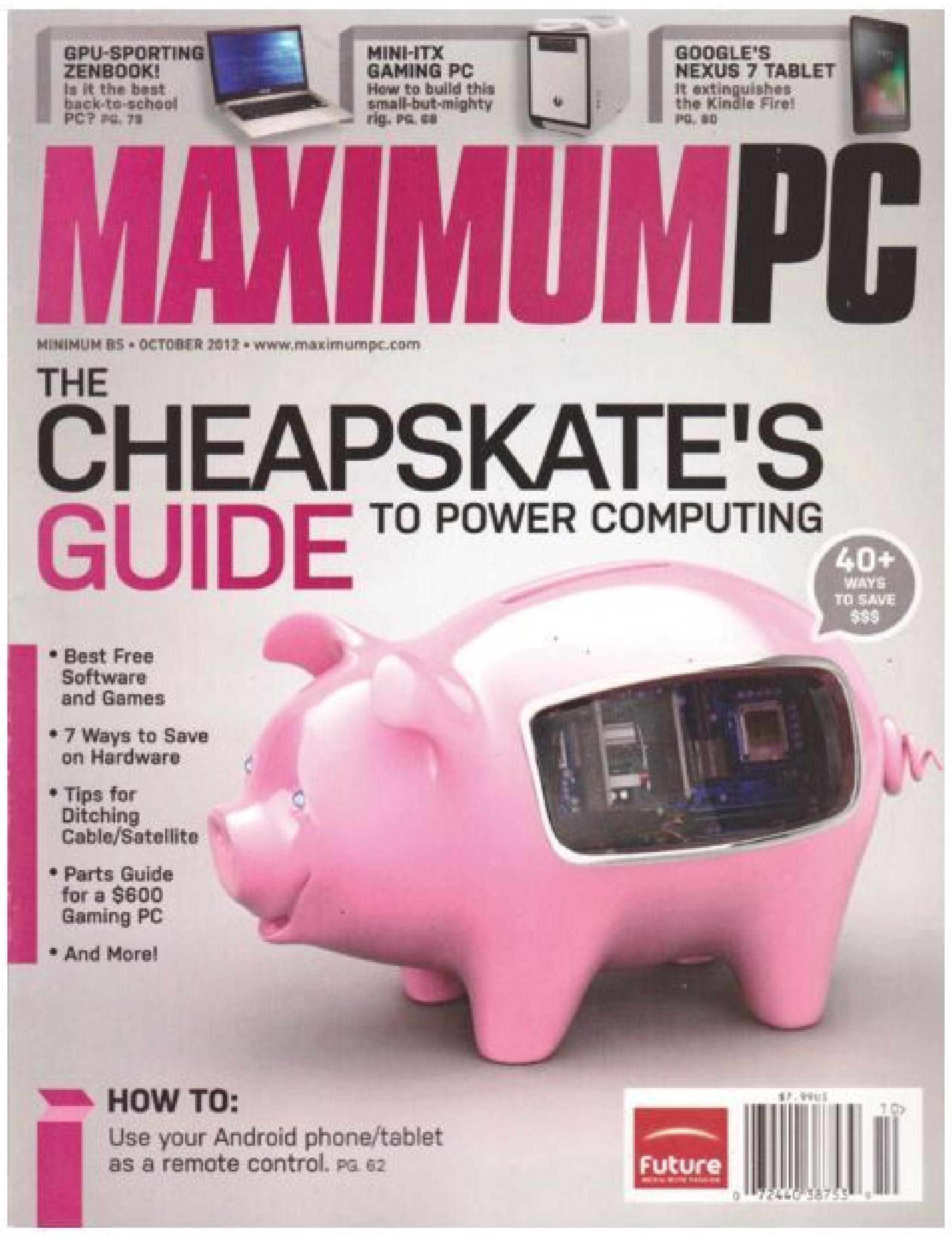
MAY 2000

PC performance was once all about the hertz, as in mega then giga. Our May 2000 issue splashed a 1GHz coverline, declaring AMD's K7 CPU a "freaking supercomputer on a single chip". The gigahertz war culminated in Intel's Pentium 4, a chip designed for frequency at all costs, that was a flop. *Max PC*'s own Tom Halfhill foresaw this in 2000, noting that clockspeed said nothing about how much work a CPU was doing each cycle.


MAXIMUM PC
MINIMUM BS
FEBRUARY 2002
HEAL YOUR PC!
38 utilities and tools to wipe out all your PC woes
FIX YOUR CRASHES, STALLS AND CONFLICTS — NOW

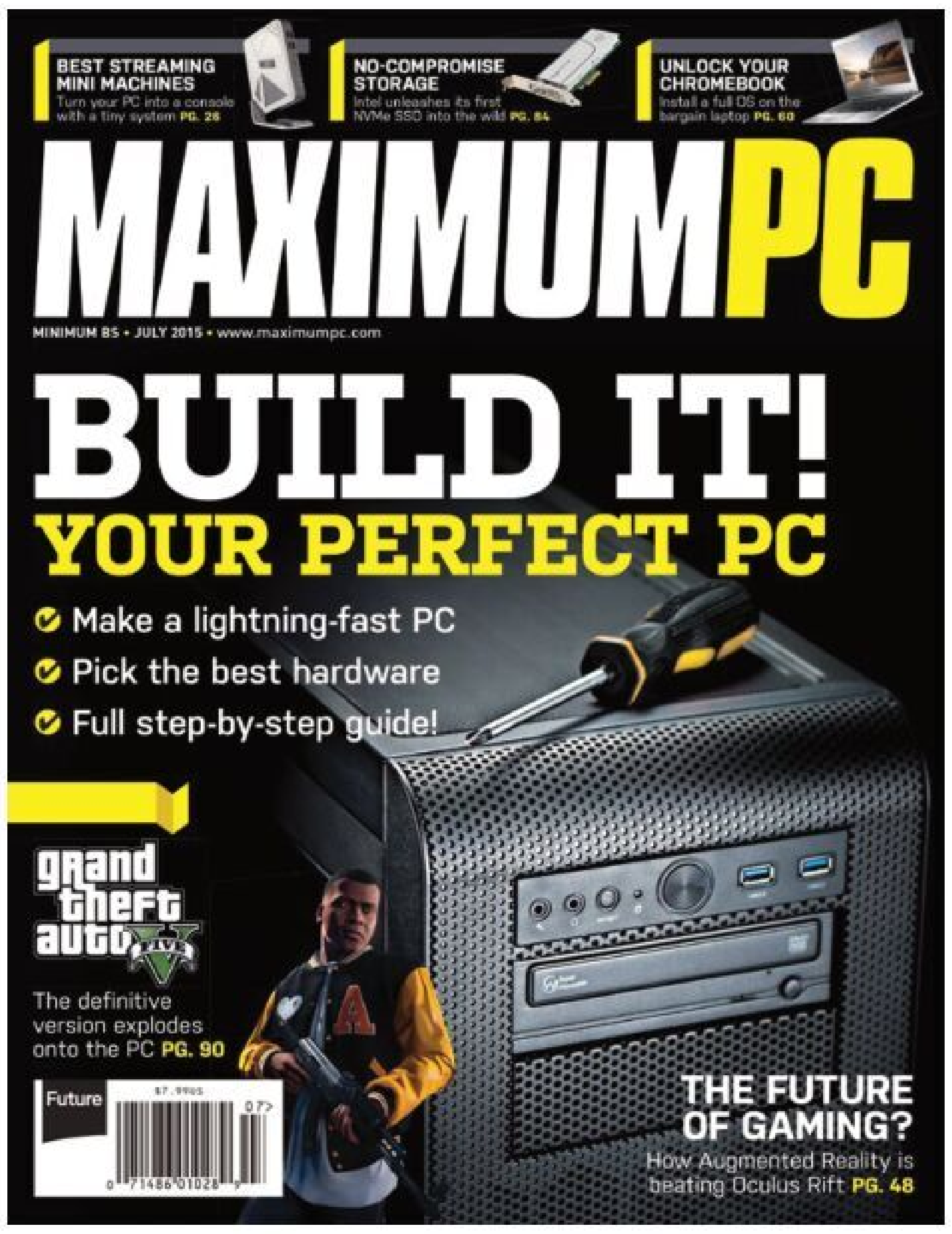
FEBRUARY 2002

Heal my PC? Yes, ma'am! 2002 feels like a long time ago and this cover looks like something from a simpler, less contentious age. Times change and we change with the times, so cover girls are a thing of the past. Something in this issue that isn't a thing of the past was 3D graphics with pixel and vertex shader accelerated effects. We experienced them for the first time, courtesy of the Nvidia GeForce 3 and ATI Radeon 8500.


MAXIMUM PC
THE CHEAPSKATE'S GUIDE TO POWER COMPUTING
40+ WAYS TO SAVE $$$
Best Free Software and Games
7 Ways to Save on Hardware
Tips for Ditching Cable/Satellite
Parts Guide for a $600 Gaming PC
And More!
HOW TO: Use your Android phone/tablet as a remote control.

OCTOBER 2012

Maximum PC's remit has never been limited to cutting-edge rigs. In fact, it's not all about buying new hardware either. That is captured by October 2012's cover story, the "Cheapskate's Guide", with the pink piggy bank being a regular down the years. Something for nothing has been a core value of the mag, with many issues majoring on free software or tips for speeding up your existing PC rather than forking out for a new one.


MAXIMUM PC
BUILD IT! YOUR PERFECT PC
Make a lightning-fast PC
Pick the best hardware
Full step-by-step guide!
THE FUTURE OF GAMING?

JULY 2015

This is surely the essence of *Maximum PC*. No pretense. No target price. Just a simple call to arms. Build it! A classic tower rig and a screwdriver illustrate the idea that has driven this magazine for over 20 years, namely building your own PC. As we noted in July 2015, the price gap between home builds and ready-made rigs has narrowed. But doing it yourself enables a laser-like focus on the specs that isn't possible any other way.

MAXIMUM PC
ULTIMATE OVERCLOCKING
Push your clock speeds to the absolute max
PLUS! Build this cutting-edge gaming PC
STATISTICAL ANALYSIS

OCTOBER 2020

Finally, we present *Maximum PC* from October 2020. The central theme is bang on message—in this case, pushing your PC to the max. It covers everything from overclocking basics to record-breaking tweaks courtesy of liquid nitrogen. It features one of the best-looking builds ever, based on the open-air Hydra Mini case, a clever bit of kit made from a single sheet of stainless steel. Like the mag, it's both easy access and high performance.

THE TOP 6 BUILD PICKS

Come with us as we take a deeper dive into some of our most interesting builds at *Maximum PC*

SO, THIS WAS CERTAINLY a tough one. We have built countless machines and rigs here at *Maximum PC* throughout the years and despite some spectacular end results, it's not all as glamorous as it may seem. There have been plenty of head-bashing moments, close calls, and blank screens on boot up. Fitting issues have occurred and last-minute parts swapping has happened more than once. However, that's all part of the passion and love we have for these builds. Every single one of them has been a journey of its own and that's what we love about working here at *Maximum PC*.

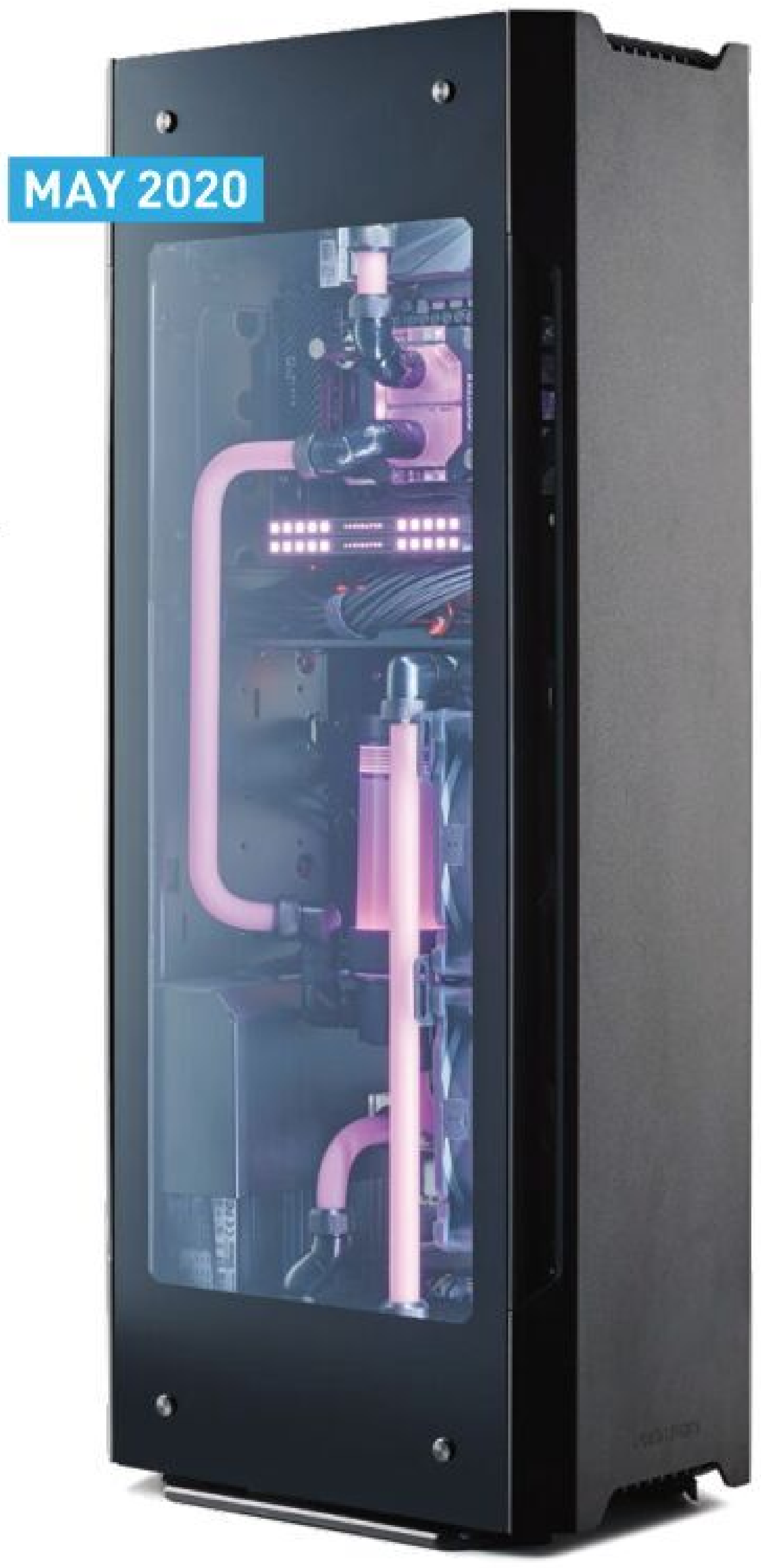
Building PCs is part of our DNA. Every single build has been so special to us and each one has a specific motive behind it. Whether that is for a standout showcase part or an interesting case. It could be sticking to a specific budget or comparing two similar machines together in a head-to-head. Many of these builds have impressive benchmarking and high-performance results—and who doesn't love a speedy beast? But sometimes it's not all about performance, a beautiful machine with equally impressive cable management also makes for a nice PC build. We treat these computers like artwork. It's all subjective, but we appreciate every single one and we hope you do too.

There are plenty of reasons why we piece together the machines we do and we know you share the same passion we do when it comes to building. Looking at our builds down the years and picking our top six was difficult, but these ones will always have a special place in our mag. They all have different characteristics but each is a standout machine that deserves a spot on this list.

boot
DREAM MACHINE
We'll Show You How To Build Your Own $5K PC
also: Over 40 Hardware and Software Releases Previewed and Reviewed

THE PINK PARIAH

GREAT CASE + LIQUID COOLING = WIN-WIN!


MAY 2020

Let's just sit back and take a minute to admire this beautiful PC. We've said that it's not always about performance and sometimes about looks, but what about the best of both worlds? This thing was designed initially as a console killer and it does that. Powered by a Ryzen 5 2600X CPU and a GeForce 2080 GPU inside, it's a nippy little thing. That's one box ticked, no more nagging from the console world. Sure, it's not the most powerful machine, but that's not this rig's party piece.

You probably noticed the brilliantly shaped Phanteks case. This literal tower named the Evolve Shift X is a great 'shift' away from the traditional cases we see day in day out. More impressive than its chassis though is of course the glowing pink veins that cool this beast down.

Yes, that's right, pink liquid cooling! Not only does this look awesome, but it also needed to work as, sure enough, this PC could crank up the heat. The only downside was that it was a nightmare to fill. While it's not exactly the most practical machine, just look at it!

DREAM MACHINE '04

FRONT-MOUNTED TOUCH SCREEN LCD? WHY NOT?

SEPTEMBER 2004
DREAM MACHINE 2004
THE MAKING OF THE DREAM MACHINE

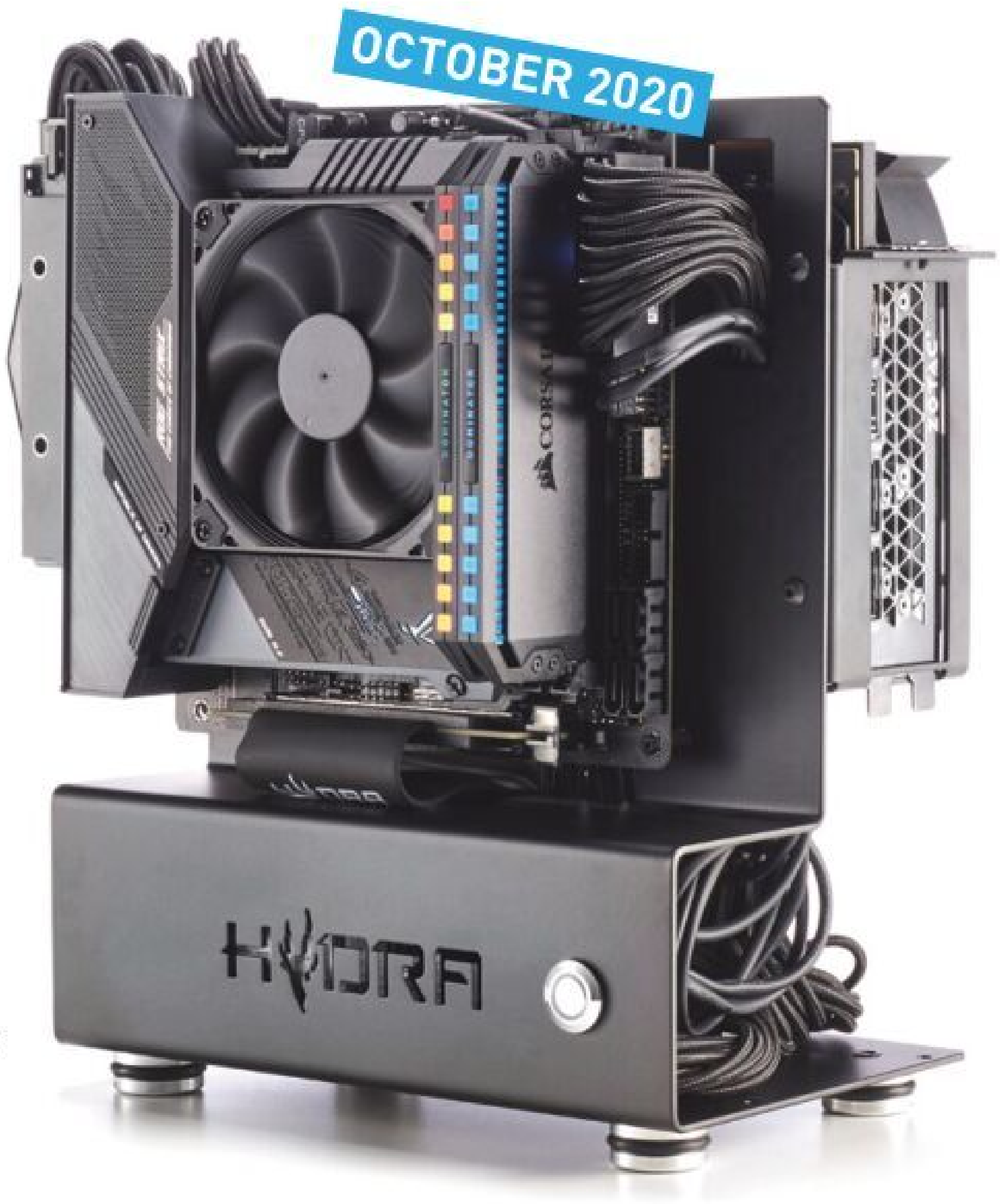
We've turned back the clocks back to 2004 and, oh boy, do we have a cool machine for you. Total overkill would undermine this PC, but that's the whole point of building a dream machine, isn't it?

It would also burn a hole in your wallet, costing around $18,000 in today's money. But, this was a special build and you can't put a price on the passion that went into this one. With a custom paint job, next-generation parts (at the time), and future-proofing in mind, this was ahead of its time.

It came fully equipped with an Intel Pentium 4 560 processor, 1GB of DDR2 from Crucial Technology, ATI Radeon X800 XT Platinum Edition graphics card, and a total of three displays. The main CTR display was from NEC with a resolution of 1920x1440. As a secondary display, we used Sharp's 37-inch TFT Active Matrix LCD. It may be a small screen by today's standards, but it was an impressive beast in its day.

Last but not least, we have the Earth LCD XLK-5002T touchscreen panel that sits in the front of the PC. Fast forward to the present and unfortunately, this hasn't become the norm, but it was a cool touch, if somewhat unnecessary. This rig was more than impressive in 2004 and it's still capable of turning a few heads in 2021.

AIR SUPREMACY
NO CASE FOR MAXIMUM AIRFLOW.



OCTOBER 2020

Continuing with the not-so-traditional builds, we have the Air Supremacy machine. This wasn't the most glamorous build we have done, but it was certainly cool, in both senses of the word.

What could possibly be more efficient at cooling than liquid cooling? How about an open machine with no external case—this thing breathes and feels alive. However, if you are in a hot room, you will still need an actual cooler, so helping out further with the cooling duties is the Noctua NH-L9i cooler, which keeps everything nicely under control.

Probably one of the best things about this from a builder's point of view was how easy it was to piece together. We all know the struggles that come from a small case, fiddly components, and dropping screws into the eternal pit of doom inside the case. However, with no case, this problem is eradicated.

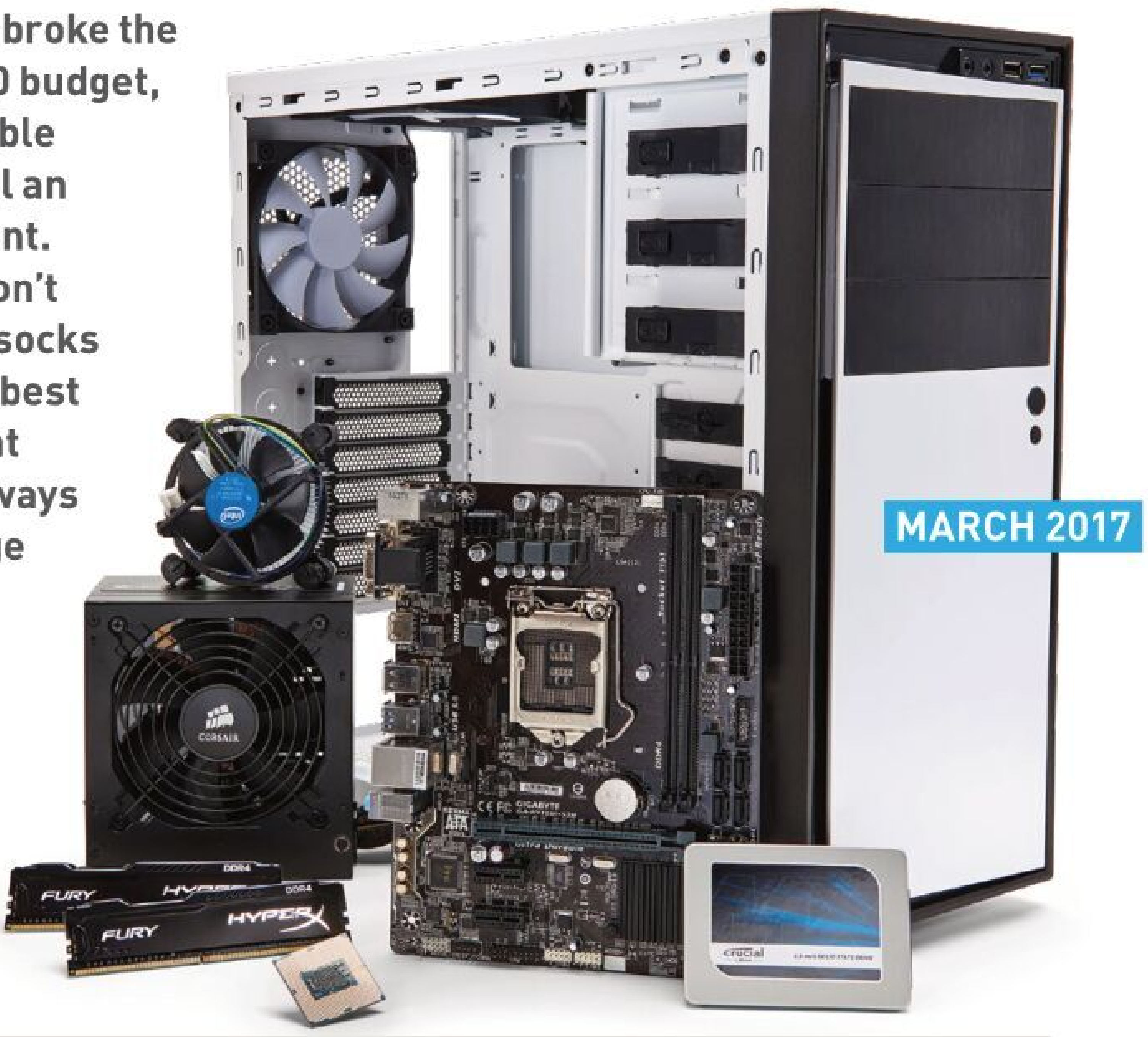
Helping power this beast is a respectable Intel i5-10600K and Zotac GeForce 2080 Super. Not only does it look epic, but it runs pretty well too.

$300 BUILD CHALLENGE
NO MONEY, NO PROBLEMS.

We don't always splash the cash—our builds are tailored for all sorts of scenarios. Yes, a fully-specced monster PC will always have a market, but how about a machine that costs less than a single CPU? In March 2017, it was team Intel vs team AMD, and though we broke the initial $300 budget, a respectable $341 is still an achievement.

No, it won't blow your socks off but the best thing is that you can always interchange parts and upgrade down the line. Consisting of a dual-core Pentium G440 processor, 8GB's of DDR4 @2400MHz, and 275GB of SSD, it goes to show you what you can achieve under a tight budget.

Starting modestly also provides you with experience of putting together a PC–and once you start, you won't stop.



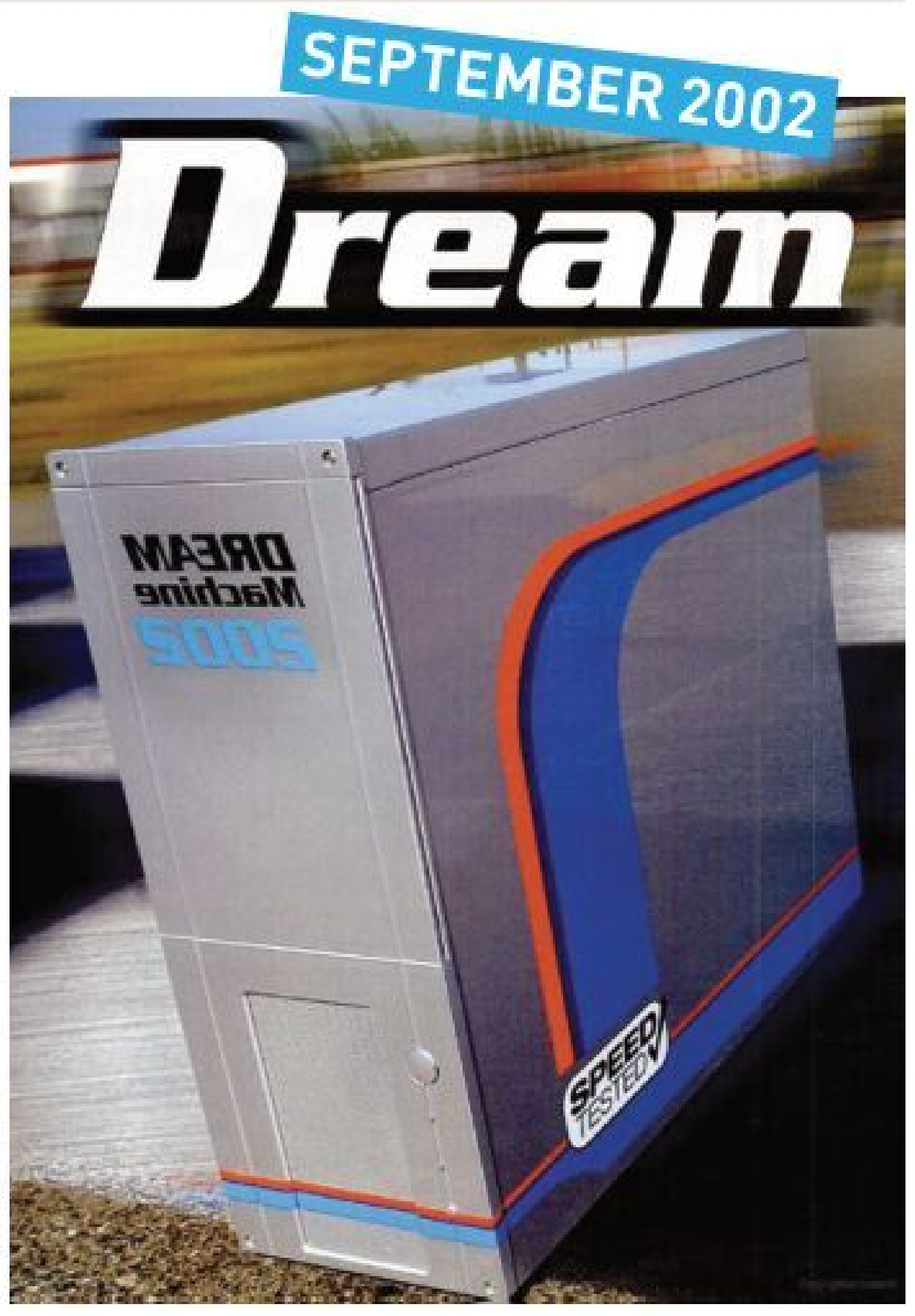
MARCH 2017

DREAM MACHINE '02
A SPEEDY DREAM MACHINE CREATED WITH AUTOMOTIVE INSPIRATION IN MIND.

There are many different reasons why we build certain PCs. There may be performance targets to hit, new parts to test out, budgets to come in under, or we may simply have taken inspiration from outside the PC universe.

The 2002 dream machine ticks the performance box, but it also draws inspiration from the automotive industry, specifically from one of the automotive giants, BMW.

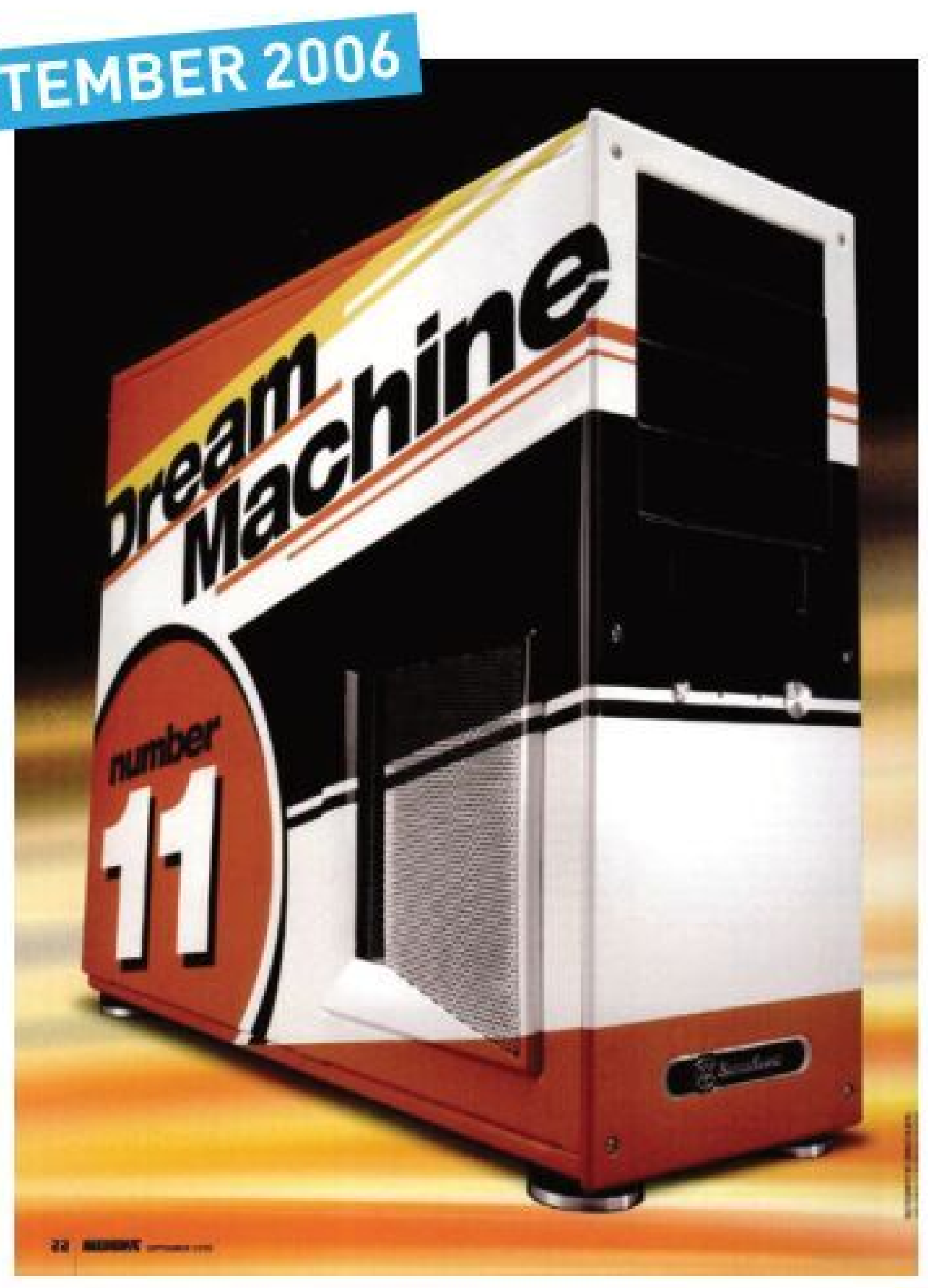
This 2002 speedy dream machine seemed like a perfect match to draw its inspiration from the equally speedy BMW 2002 Turbo, one of the company's most timeless models. This stunning car was finished in BMW's Polaris silver paint with the iconic M Sport stripes to contrast and we paint matched our dream machine to this exact spec. It's fair to say that the Cooler Master ATC110 case came out perfectly and paid a fitting homage to the BMW classic.



SEPTEMBER 2002

Aesthetically it looks great, but it wasn't all about the looks, and this beast certainly had the performance to match. An Intel Pentium 4 processor that was overclocked to 2.8GHz and an ATI Radeon 9700 128MB card helped to power this elegant beast. With great inspiration and an impressive power plant under the chassis, what's not to like about this dream machine?

DREAM MACHINE '06
BOLD PERFORMANCE WITH A BOLD PAINT JOB.



SEPTEMBER 2006

Custom paint jobs were a big part of our builds and throughout the years, we have had quite a collection to choose from. While every dream machine is precious, there's just something about this one from 2006 that does it for us. Courtesy of Smooth Creations, the combination of orange, white and black creates a bold build and striking touch to the Silverstone TJ09 chassis.

The case has a pretty interesting solution to help with the airflow. In the lower portion, there is a large ventilation chamber. Stick a fan at the entrance and it will suck cool air through the chamber and into the side vent, providing cooling lower portions of the build.

The rest of the build is equally impressive, and it showcased the introduction of a new Intel chip that aimed to take back the throne from team AMD back in the day. Specifically, Intel's then-new Core 2 Extreme X6800, aka "Conroe". This 2.93GHz chip swamped the Athlon 64 FX-62 on all the benchmarks and was a real powerhouse chip back then. As if the chip wasn't powerful enough, two XFX GeForce 7900 GTXs in the nForce 590 SLI Intel Edition motherboard rounded off a pretty speedy system. Paired with that beautiful case, it makes for an awesome rig.

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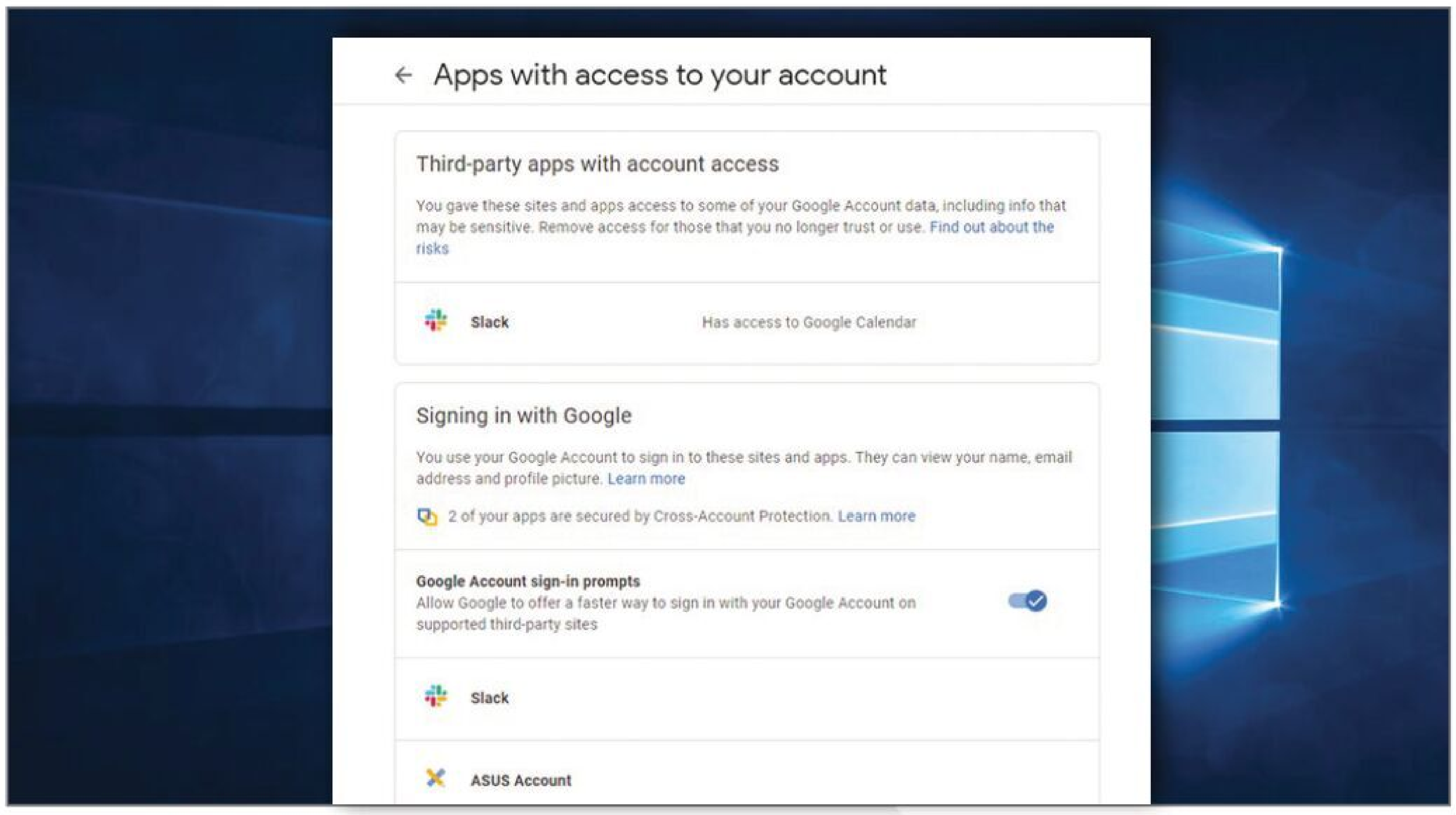
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



← Apps with access to your account

Third-party apps with account access

You gave these sites and apps access to some of your Google Account data, including info that may be sensitive. Remove access for those that you no longer trust or use. Find out about the risks

Slack Has access to Google Calendar

Signing in with Google

You use your Google Account to sign in to these sites and apps. They can view your name, email address and profile picture. Learn more

2 of your apps are secured by Cross-Account Protection. Learn more

Google Account sign-in prompts
Allow Google to offer a faster way to sign in with your Google Account on supported third-party sites

Slack

ASUS Account

GOOGLE ACCOUNT PERMISSIONS

Privacy is one of the most important things to keep on top of when using a PC. With your photos, contacts, financial details, and much of your life held on there, your PC could be a goldmine for those pesky hackers. If you have a google account, there is a page where you can quickly check to see which apps have access to your account. Type the following into your search bar to have a look: myaccount.google.com/u/0/permissions

MAKE – USE – CREATE

60
Make your own
Pop Art with
Adobe Photoshop

Windows on Raspberry
About
Welcome
Select device
Select image
Select drivers
UEFI firmware
Configuration

Welcome to Windows on Raspberry!
This wizard will help you easily install the full desktop version of
on your Raspberry Pi computer.

Click on the Next button to continue.

Select your language: English

64
Run Windows 11
on a Raspberry
Pi 4 Yes, really!

66
Music production
for beginners
using your PC

© MICROSOFT/GOOGLE

SAM LEWIS
STAFF WRITER

FACE PALM

GTA: The Trilogy Definitive Edition was on the agenda for the last issue, and I'm sure I won't be the first to say that it was a letdown. Not only for fans who were excited for this nostalgia hit, but for Rockstar games, too. You'd have thought that it would have gone over the release with a fine-tooth comb. But with so many glitches, this feels like a filler project.

These titles paved the way for open-world games, so the appeal of reliving these in a remastered fashion was huge. As a fan of the *GTA* catalog, I would have rather waited until these bugs had been fixed. It seems as though *GTA 5* is raking in the cash and other projects have been put on the back burner. Saying that, I loved *Red Dead Redemption 2*, the level of detail in that game was superb and is part of what makes Rockstar games so good. Every corner of the map is there to be explored with lots of hidden easter eggs and side quests.

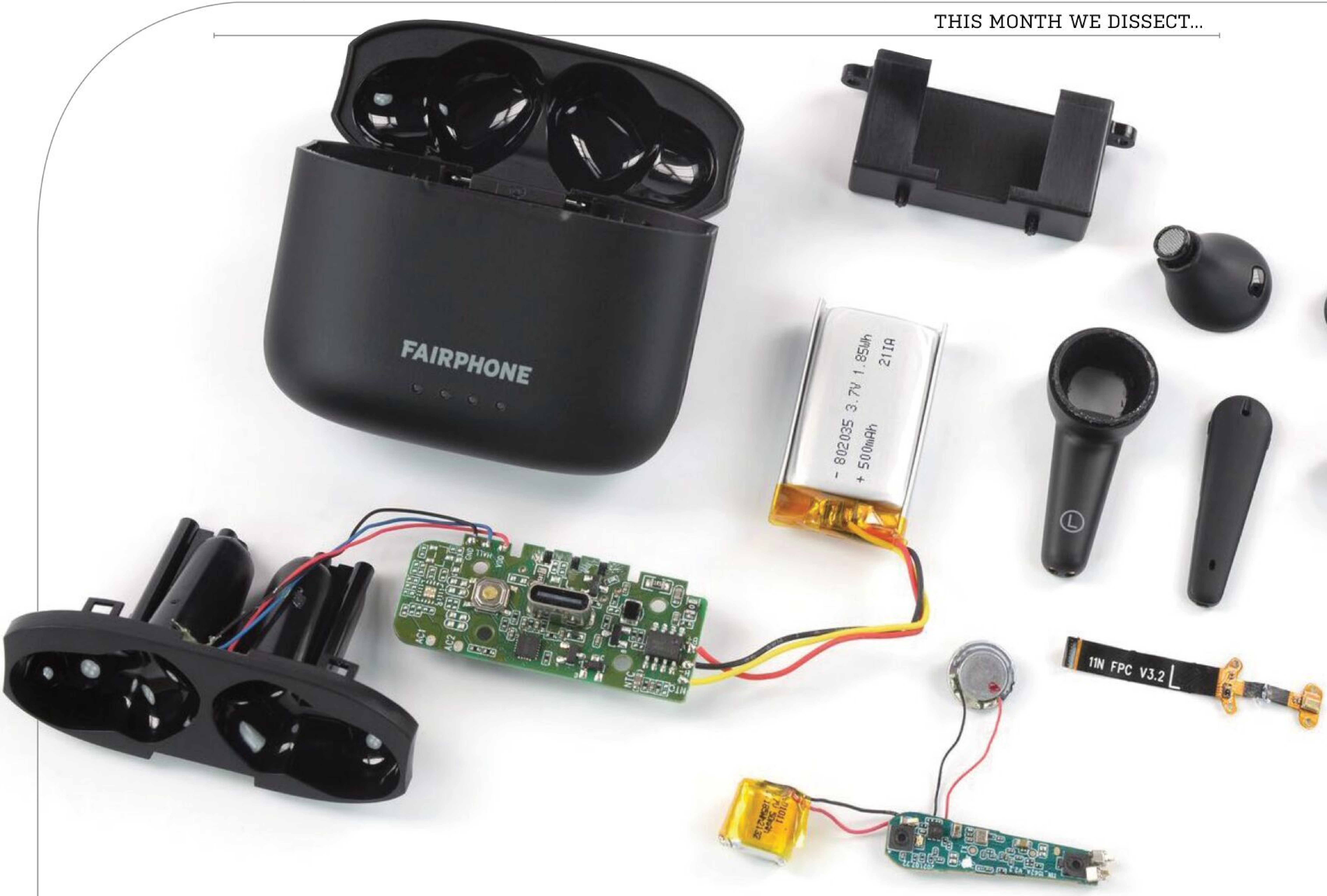
To find issues such as a vanishing bridge in the remastered San Andreas was a disappointment. It could have been a huge success for Rockstar and while updates will come out with patches, the initial damage has been done. In the meantime, I have hopped back on *GTA 4* and am replaying the whole story. I'll come back to the trilogy when some major patches are available.

↘ submit your How To project idea to: editor@maximumpc.com

IFIXIT
presents:

AUTOPSY

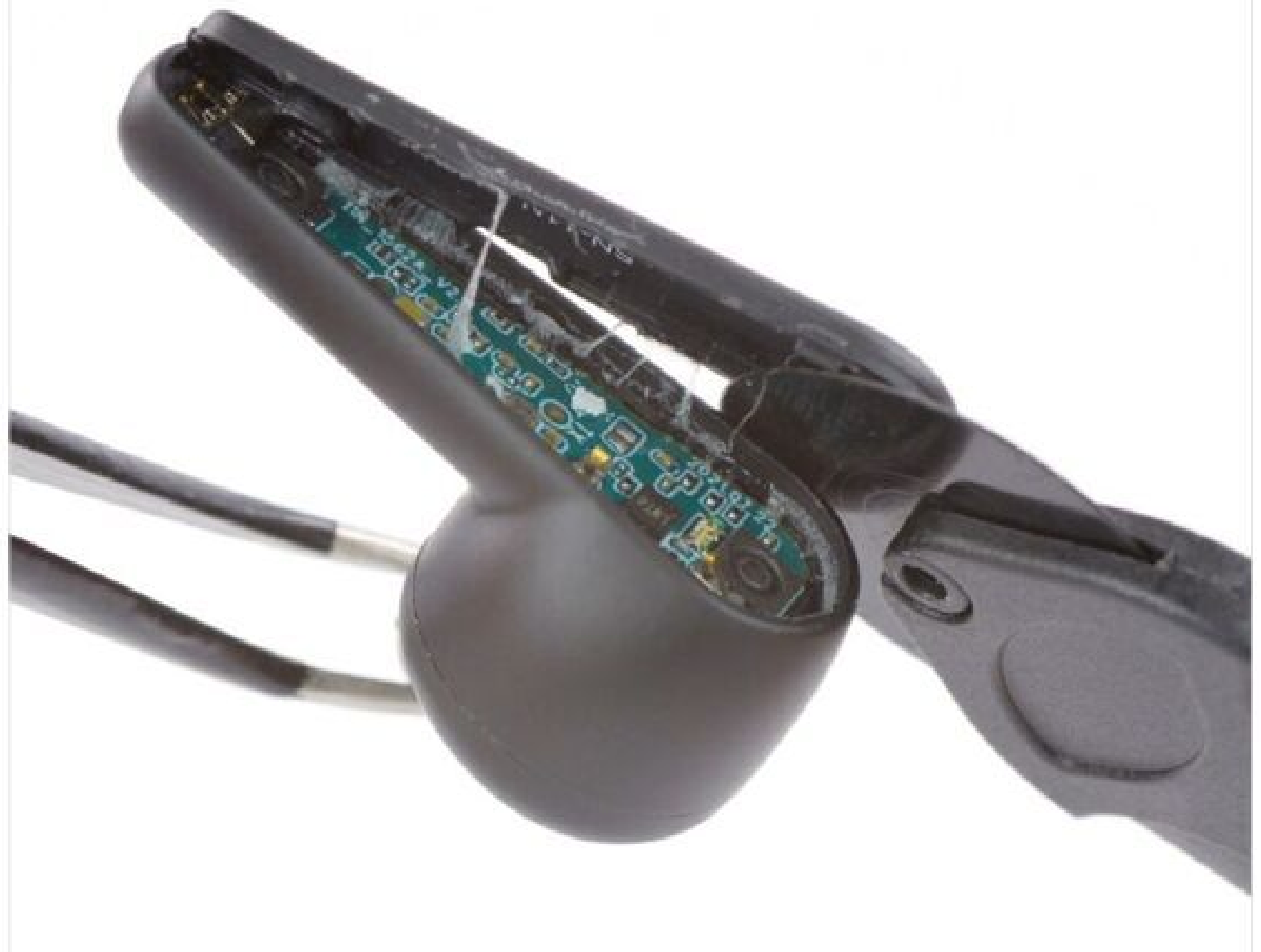
THIS MONTH WE DISSECT...



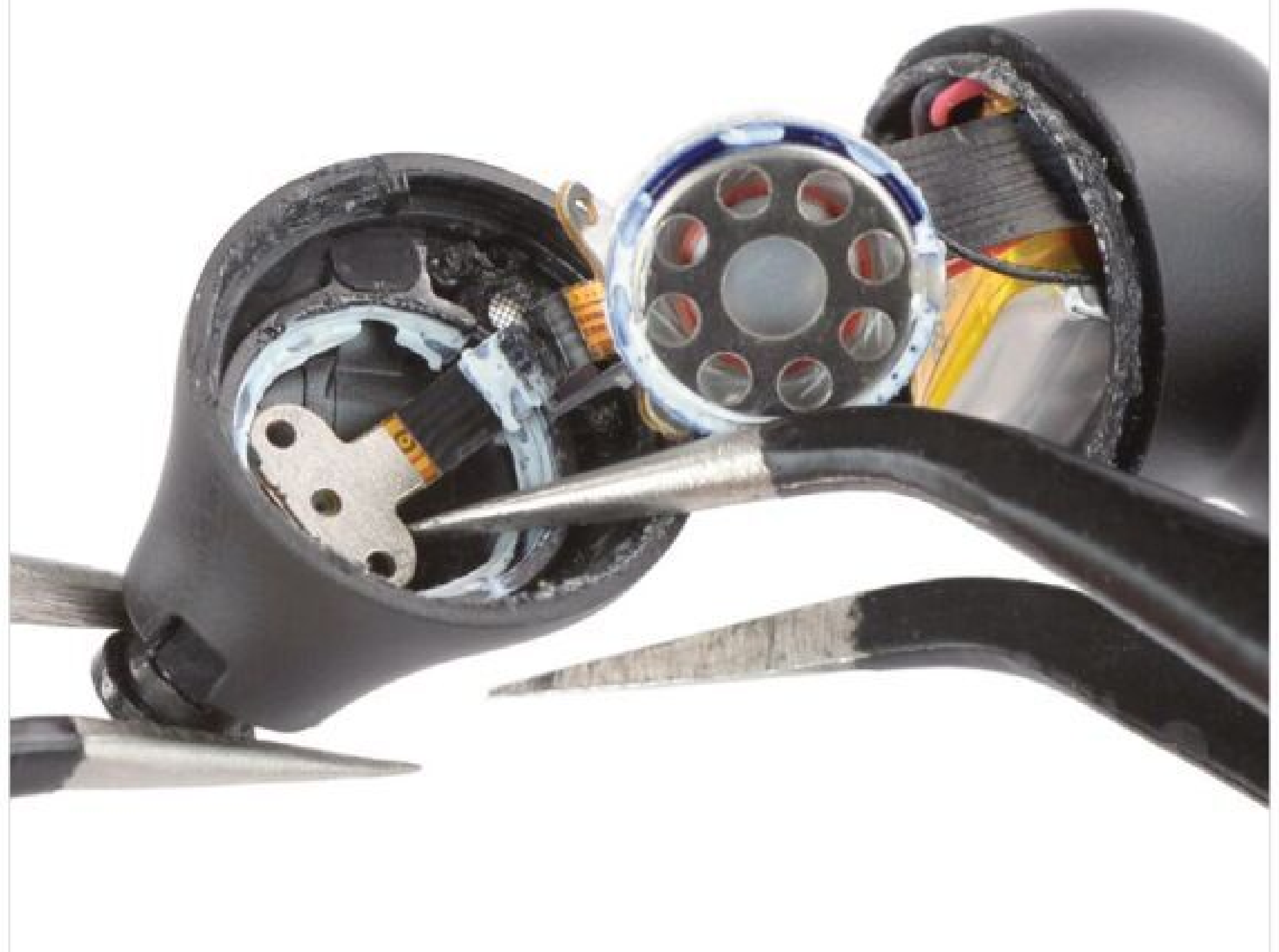
About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

The plate we peel up has the touch controls mounted to it, but your taps are communicated via spring contacts, so there are no booby trap cables in sight.



While we're no fans of glue, we're even less fond of destructive fasteners. At least glue can be reapplied.



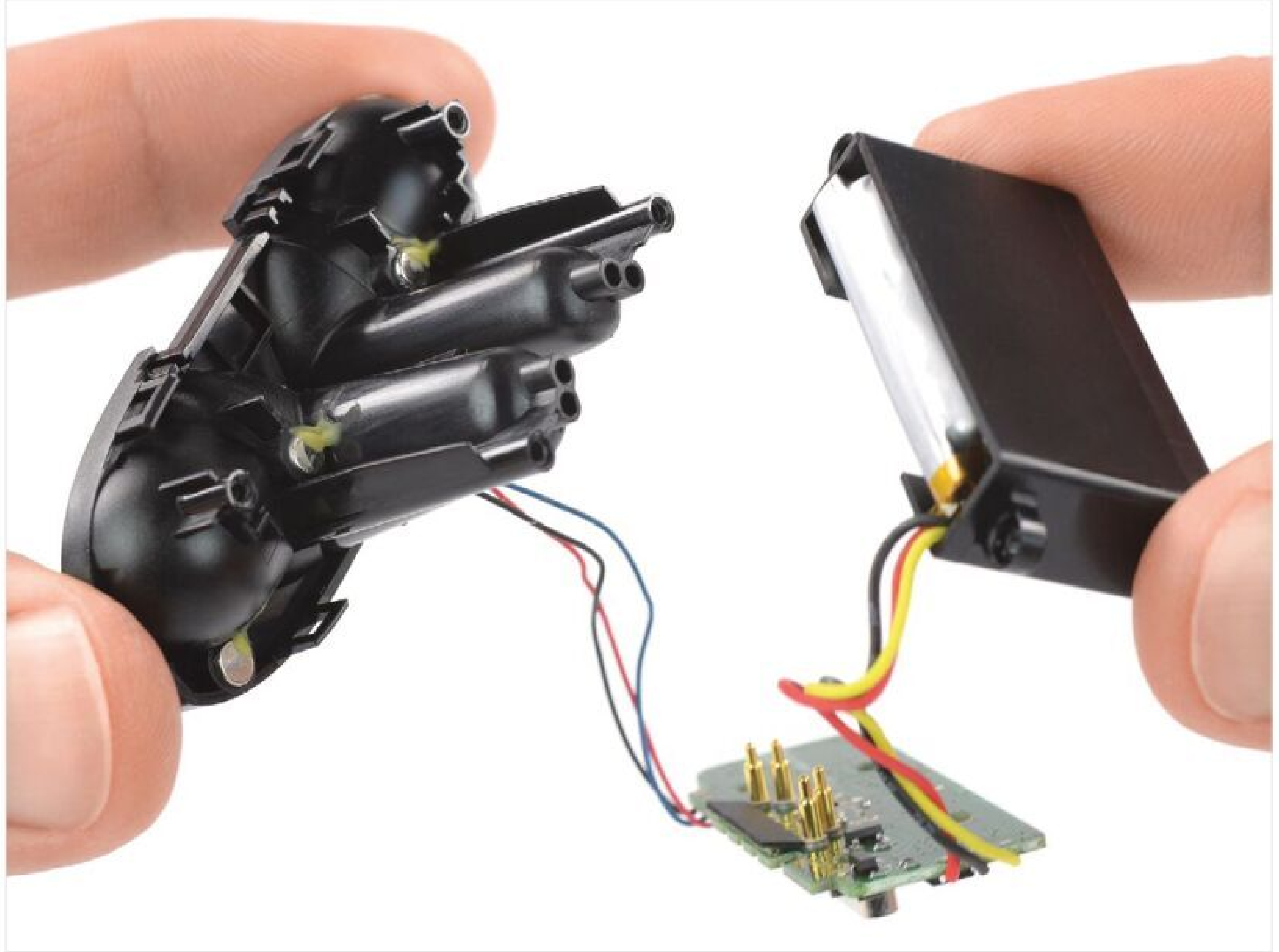
For comparison (l to r): Fairphone True Wireless Stereo Earbuds, AirPods Pro, Nothing ear (1), Samsung Galaxy Beans Buds Live, Galaxy Buds+

Fairphone True Wireless Stereo Earbuds

The case battery provides 1.85Wh (500mAh @ 3.7V), which should re-juice those twin 0.1Wh earbud batteries a handful of times.

802035 3.7V
500mAh

This case seems to be allergic to connectors, unless that battery pack is hiding some surprise.



BACKGROUND

Welcome, Fairphone, to the world of wireless earbuds. Fairphone smartphones consistently rank tippy-top for repairability, so will its True Wireless Stereo Earbuds manage the same trick?

MAJOR TECH SPECS

- In-ear detection and touch control
- Active noise cancellation with transparency mode
- Bluetooth 5.3, A2DP, HFP, AVRCP (Airoha AB 1562 Bluetooth audio SoC)
- 10 mm / 32 Ohm drivers
- IPX4 splash resistance
- 10×9.8×5.6 mm, 0.1 Wh battery

KEY FINDINGS

- We kick off disassembly with the most removable, and cleanable, bit: the flexible tips—much like you find on competing models, including AirPods Pro. With three different size options, you've got a good chance of finding a set that fits.

- Next, hoping to keep it nondestructive, we aim for a likely seam and get slicing with an opening wheel—no heat required. The plate we peel up has the touch controls mounted to it, but your taps are communicated via spring contacts, so no booby trap cables in sight! Inside, we can already spot the glued-in motherboard. Forcing it out seems unwise, so we'll backtrack a bit and try what has become our standard opening procedure for the generally not-so-repairable earbud category.

- Putting the squeeze on the speaker portion of these buds, with help from our trusty bench vice, deforms the buds' outer shell just enough to open up a chink in the armor— a seam. Pressure and heat make diamonds, and also progress on our teardown. After some picking and prying, we see a tiny battery pouch deep inside—but it's mostly cables and solder in there.

- We opt for battery removal, because it gives more room to maneuver, and because this cell will someday need replacing anyway. Fairphone says they're engineered to last "twice as long" as the competition, but that's not saying much. On our way to the driver (which is glued down in a super-tight recess), we see the ribbon cable held captive by brackets, which in turn are secured by plastic rivets. With heavy hearts, we break out the flush cutter—it's about to get destructive in here.

- Since at first we're not succeeding, we pry, pry again with some heat and a deft spudger. The buds finally give up their (decidedly non-modular) internals: motherboard, driver, and battery. On this side of the motherboard, we find an indicator LED and spring contacts for touch controls and for charging the buds.

- The earbuds were a disappointment, so hopefully, the charging case will prove more cooperative. A spudger is all we need to move the insides outside—no glue and no screws. We feel the optimism building, but alas, separating the bits reveals a whole bunch of soldered cables.

- There's no adhesive for its protective sleeve, but the battery is certainly securely soldered. The rest of the cables are similarly soldered, we also spot a simple hall effect sensor up top to track the lid state (open/closed).

- Repairability Score: 1 out of 10 (10 is easiest to repair). We may have had inflated hopes for Fairphone's first earbud offerings, but we're still disappointed they aren't easier to service. While the earbuds can be opened with gentle prying, nothing inside is easily repairable. The charging case and earbud components, including batteries and port, are soldered together. Fairphone does things right with its earbuds' materials (Fairtrade Gold and recycled plastics) and we're all for that. It just won't lengthen device life as repair does.

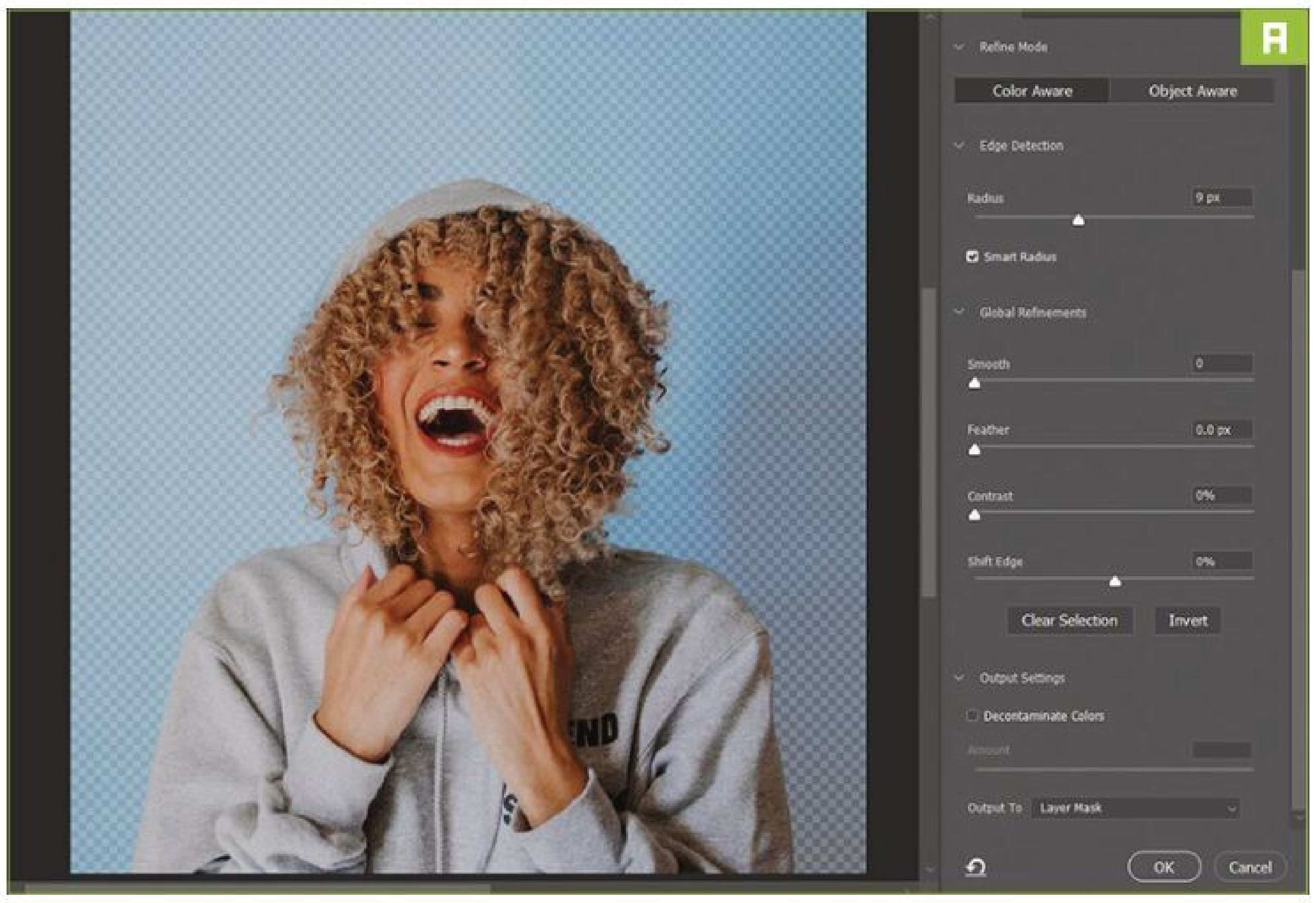
Photoshop Pop Art

YOU'LL NEED THIS

ADOBE PHOTOSHOP CC 2020
https://www.adobe.com

IN THE WORLD OF ART, there are many different styles, ranging from abstract to modernism, and surrealism to cubism—and that's not forgetting what was thought to be the first modern art movement, impressionism. There have been many art styles since and each has contributed toward the main framework of art as a whole. Styles and genres come and go, but some seem to stick around for good reasons.

Rising to fame in the late-1950s, the pop art movement is a bright and bold form of art, pioneered by artists such as Roy Lichtenstein and Andy Warhol. Now considered one of the most significant art movements of the 20th century, pop art inspired many different sub-art forms and the influence of its bright, bold, and fun vintage style can still be seen across a variety of different media. The great thing about pop art is that you can take multiple elements from the genre and apply them to your own work or imagery. In this tutorial, we will be converting a regular photograph into the style of pop art using Adobe Photoshop. –**SAM LEWIS**



Radius 9 px
☑ Smart Radius
Smooth 0
Feather 0.0 px
Contrast 0%
Shift Edge 0%
☐ Decontaminate Colors
Output To Layer Mask

1 SELECT YOUR IMAGE

Before we get going, you will first need to select an image. Decide on the type of image you want to convert into pop art—this can either be black and white or a color image, but for the best results it helps if you choose one that has a strong contrast between the foreground and the background as we will be cutting around the image later on.

›› If you don't have an image at hand or you simply want to practice before trying it on one of your own photographs, a great website to download license-free photography is Unsplash (www.unsplash.com). We select an image by Ivana Cajina on Unsplash to use for this example.

›› Once you're happy with your image, open it up in Photoshop. The first thing we do is rename our image and create a duplicate layer and lock it in case we need to go back to the original. Then we convert our main layer into a smart object so we can modify and replace it if we need to, without having to reverse the effects that we are going to add later on. To do this, you can right-click on the layer and select 'convert to smart object'.

›› Before we go any further, we can crop the image if necessary. In the toolbar on the left-hand side, select the rectangular marquee tool and draw around the part of the image that you would like to keep. Then go to image and crop. To deselect it, use the shortcut 'CTRL + D'.

›› To finalize the image before adding some pop art magic, make sure the image resolution is at 72 pixels per inch, you can check this by heading over to the image, then check the image size in the top bar. Select this and change it to 72 pixels per inch, if it isn't already.

2 LET THE TRANSFORMATION BEGIN

Now we can begin adding the transformations. The next thing we need to do is separate our subject from the background. There are many tools for this, including the pen, magic wand, or quick selection, so use whichever you feel most comfortable with.

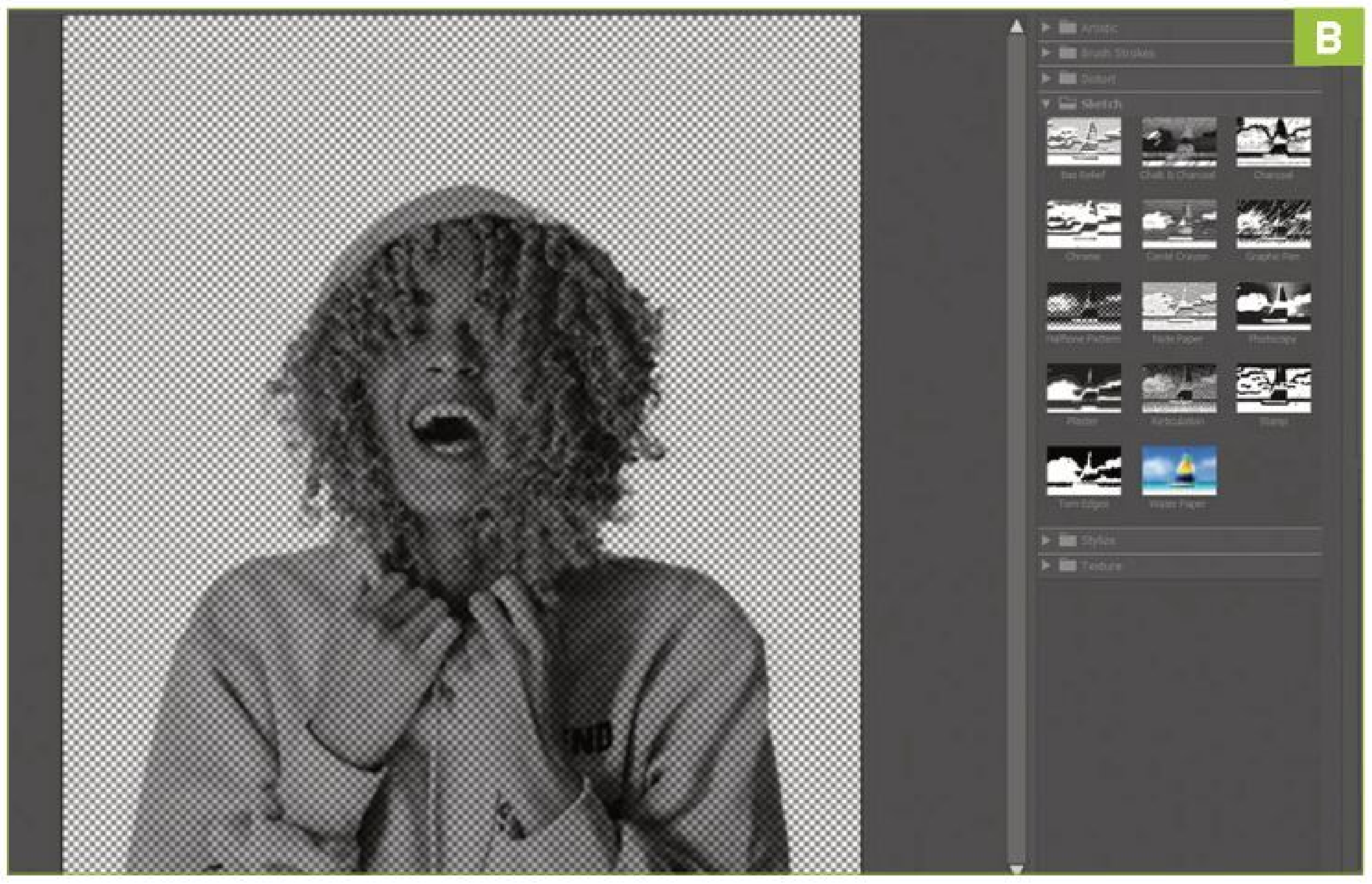
›› We use the quick selection tool in the left-hand side tool panel and once we have drawn around the subject, we go to the select tab at the top and click 'select and mask' [**Image A**]. On older versions of Photoshop, this will be called 'refine edge'. In these settings, you can tidy up the edge of your selection. We increased the radius and made sure that the 'smart radius' was selected.

›› Keep drawing around until you are happy with your selection. Then scroll to the bottom to change the output selection to 'layer mask'.

3 CUT IT OUT

Your image has now been cut out appropriately, so click on the new layer button while holding down the CTRL key to open a new layer underneath your active one. We will fill this color with white, but first, check that your active colors in the left-hand toolbar are black and white already. Make sure white is the background color then on this new layer press 'CTRL + delete' to replace the transparent background with white.

›› If your image is in color, then you will need to desaturate it. You can do this by selecting your subject's thumbnail then going into the adjustment layer tab and selecting 'black & white'.



© ADOBE

4 LOTS OF DOTS

Once this is done, we will convert these layers into one smart object. Whilst holding the shift key, select the appropriate layers, right-click and select 'convert to smart object', as before. We are doing this so that we can add filters to it, head over to the filter tab in the top bar, and select 'filter gallery' from the drop-down menu [**Image B**].

›› Use the 'halftone pattern' filter in the sketch menu of the filter gallery. Play around with the size slider until you are happy with the size of the dots. Then slide the contrast all the way to 0 and make sure the pattern type is 'dots'.

›› Now, hit OK and then go back into the filter menu, sharpen, then smart sharpen. This will open up a pop-out window. In this, turn the amount up to between 200 and 500 percent, move the radius up to an amount you are comfortable with (we chose 2.3px), and turn the noise down to zero. There are more shadow and highlight settings you can tweak until the image is right for you. At this stage, it should look like a vintage dotted pop art image, but in black and white. Once you are happy with it, hit OK.

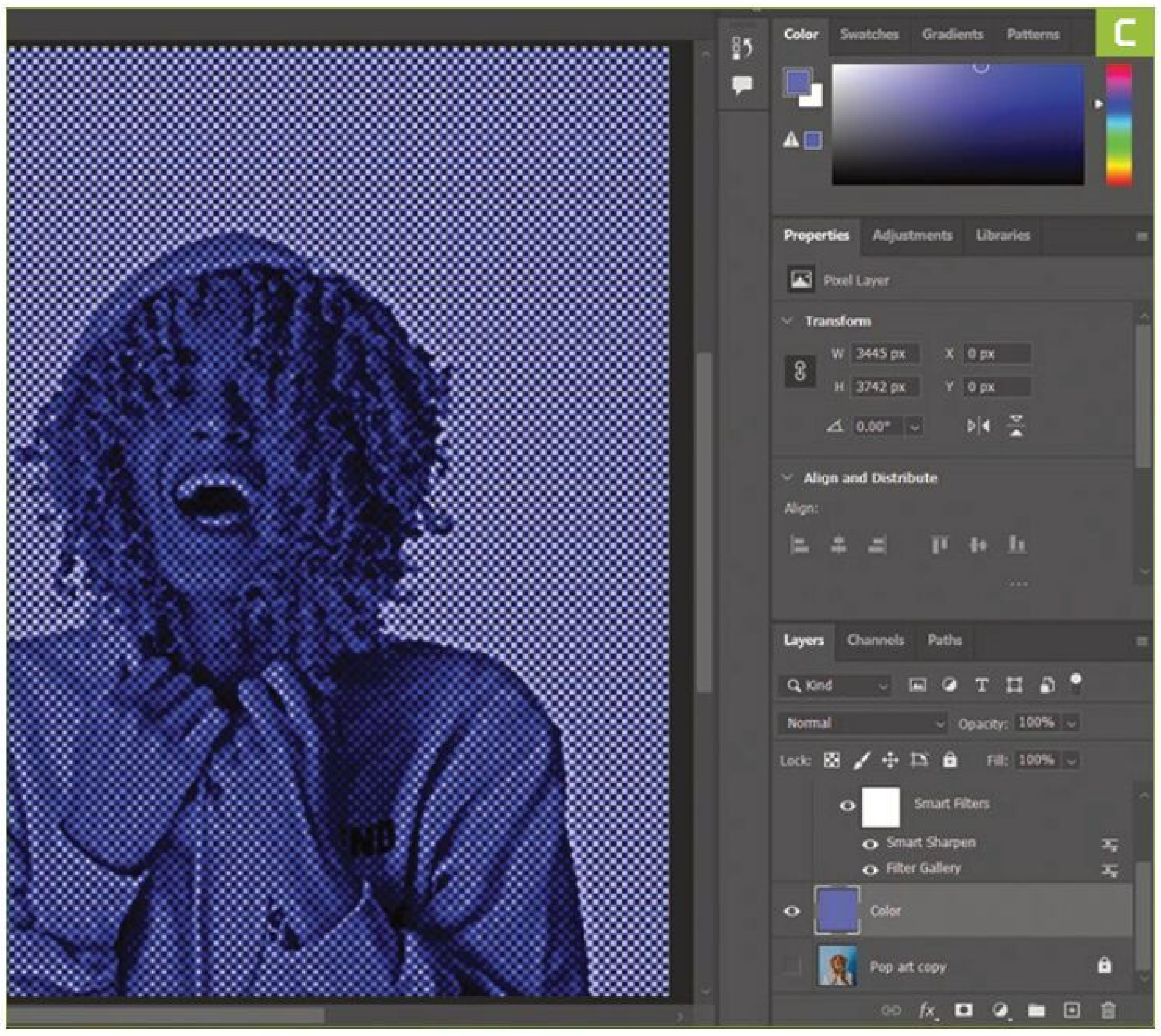
5 LEVELS UPON LEVELS

The next tweak we need to do to our artwork is altering the levels. With your main layer selected, click the adjustment layer icon (the half and half-circle icon at the bottom of the right tool panel) and click 'levels'. This should open up the level's adjustment panel.

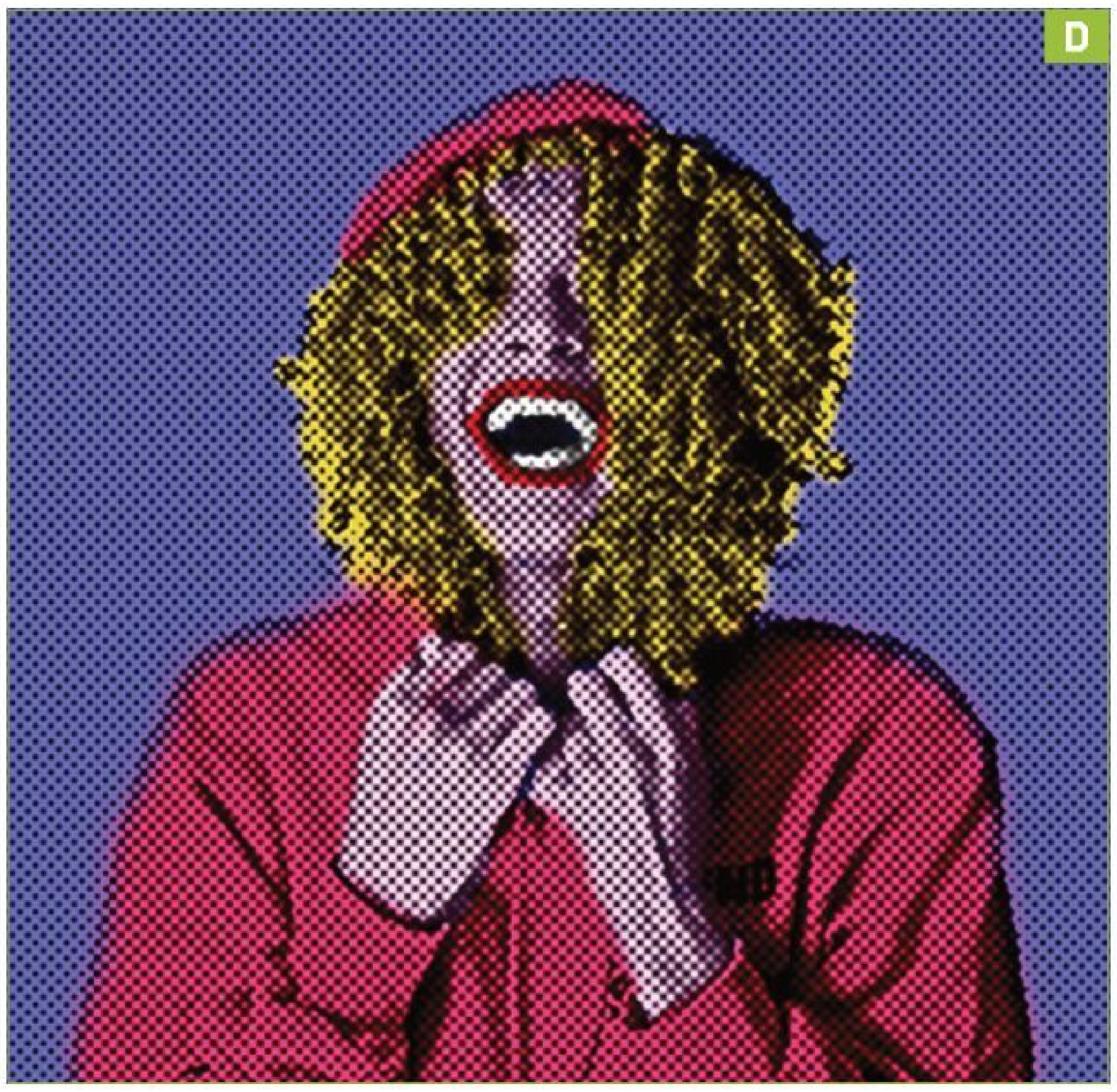
›› Here, there should be a graph with three figures underneath, the figure on the far right alters the input white level and this is the one we will be adjusting to brighten the image. Change this from anywhere between 100 and 200 depending on your image to brighten it a little and create more contrast.

›› After this, we will be clicking on the subject layer once again and changing the blend mode to linear burn. We will then be adding a blank layer below the subject layer by holding 'CTRL' and clicking on the new layer icon, near the adjustment layer icon we mentioned earlier. We can change this layer name to 'color'.

›› For a close representation of the original image, try to choose similar colors from that shot. Our background was originally blue, so we picked a similar bold blueberry color for more of that 'pop art' effect. Go to the color palette, click on the foreground color, and once you have found the one you like, hit OK [**Image C**]. Then press the 'ALT + Delete' keys together to add the color to the image.



W 3445 px
H 3742 px
X 0 px
Y 0 px
0.00°
Normal
Opacity: 100%
Fill: 100%



6 GET OUT THE PAINTBRUSH

Now make sure the level's adjustment layer is affecting the subject, not the background. To do this, select the levels layer, and click the clip layer icon above the layer panel (it's a box with an arrow coming from the left side of it). Hitting this will clip it to the one layer below it. Or, use the 'CTRL + ALT + G' shortcut.

›› Finally, start painting your image. Choose colors that contrast well to use throughout the image. Using the brush tool with a hardness of around 25 percent, choose a color to represent the skin and paint over your image on the color layer, then paint the hair and clothes. Refer back to the original image to highlight the main details of the subject. Don't worry about neatness, pop art is supposed to be a bit rough around the edges. It's experimental, fun, and an integral part of modern art.

›› Hopefully, you should have a similar piece of art to our example shown above [**Image D**]. It's a great method to create some powerful and quirky images to add to all sorts of elements in your work. Keep going back through this tutorial and practice with different kinds of imagery to get the best results. ⏻

SHORTCUTS

Efficiency in Photoshop, or any other productivity program for that matter, is crucial. We know how easy it is to lose hours on end when you are trying to perfect your designs, so any method that can reduce this is a bonus. Speeding up your work is not only great for time management, but it can also help you commercially if you are taking your design work to the next level.

One way of doing this is through the use of keyboard shortcuts. While they take some time to get used to, with practice, they soon become second nature. Adobe's website (www.adobe.com) lists all the default shortcuts available. These shortcuts can vary between different applications, but you can also alter them to suit your needs. The site is regularly updated to keep you in touch with the latest software updates. Using these and getting to grips with them should hopefully give you a helping hand with the speed at which you can create your artwork.

Machine of the Month: Texas Instruments TI-99/4A (1981)

YOU'LL NEED THIS

A COPY OF CLASSIC99
http://harmlesslion.com/software/classic99

THIS MONTH we feature a cult computer that could have dominated the early 1980s but fell short of fame due to bad management decisions. Instead, machines such as Sinclair's ZX80 and ZX81 and the Commodore VIC-20 became the standard-bearers for a new era of home computing. Nevertheless, the TI-99/4A had a sizeable following, offering retro computing fans a combination of features not found elsewhere and some interesting arcade action. –JOHN KNIGHT

1 DEVELOPMENT & RELEASE

Before the TI-99/4A came 1979's TI-99/4. When 8-bit microcomputers were just becoming mainstream, Texas Instruments (TI) had the ambition of releasing a 16-bit home computer, based on its own TMS9900 CPU.

» As the first 16-bit home computer, this machine had the potential to dominate the home computing scene, with a 3MHz CPU, 16KB of RAM, 15 colors, 32 single-color sprites, and 4-channel audio, powered by Texas Instruments' own chipsets.

» However, the TI-99/4 had a botched launch. The TI-99/4 only received a chiclet keyboard. Wanting to keep tight control over software licensing, TI only gave developer information to a few software houses. To get around strict requirements from the FCC, TI simply bundled a modified color television with their computer, greatly increasing its price.

» The TI-99/4 launched for $1150 (around $4,100 today), but it flopped, selling somewhere between 20,000 and 100,000 units. It was too expensive, the keyboard was nasty, and the company's strict software policies resulted in few applications.

» Nevertheless, Texas Instruments didn't give up on its machine, returning in June 1981 with the TI-99/4A. The new "A" model still had the same CPU and RAM, but improved on its older sibling with a full-stroke keyboard, lower case characters, and a new TMS9918A video chip, later used in the Sega SG-3000 and MSX, which allowed bitmapped graphics.

» Relaxed FCC regulations meant TI's new machine could be used with regular television sets, allowing a drastic price reduction. At just $525, the TI-99/4A was now market competitive.

2 PERFORMANCE & GAMING

Don't expect Amiga-like performance from those 16 bits. TI's shoehorning of a 16-bit processor into a mostly 8-bit system didn't work. Workarounds were used to interact between the 8 and 16-bit components, and the 16-bit portion could only access 256 bytes of 'scratchpad' RAM and 8KB of internal ROM.

» Nevertheless, the TI-99/4A still has tricks up its sleeve. The TI-99/4A is more graphically sophisticated than most machines of the early '80s, with smooth motion and proper sprite handling.

» For example, *TI Invaders* (1981) is an excellent *Space Invaders* clone, with animations and independent coloring. 2014's TI-99/4A remake of *Sabre Wulf* is superior to the ZX Spectrum release, with smoother movement and no color clash.

» However, the system's most impressive asset is its Speech Synthesizer add-on, which uses the same chips as Texas Instruments' Speak & Spell toys. Although other microcomputers had similar add-ons, the TI-99/4A's was employed much more extensively, featuring in arcade titles, educational packages, and even BASIC games.

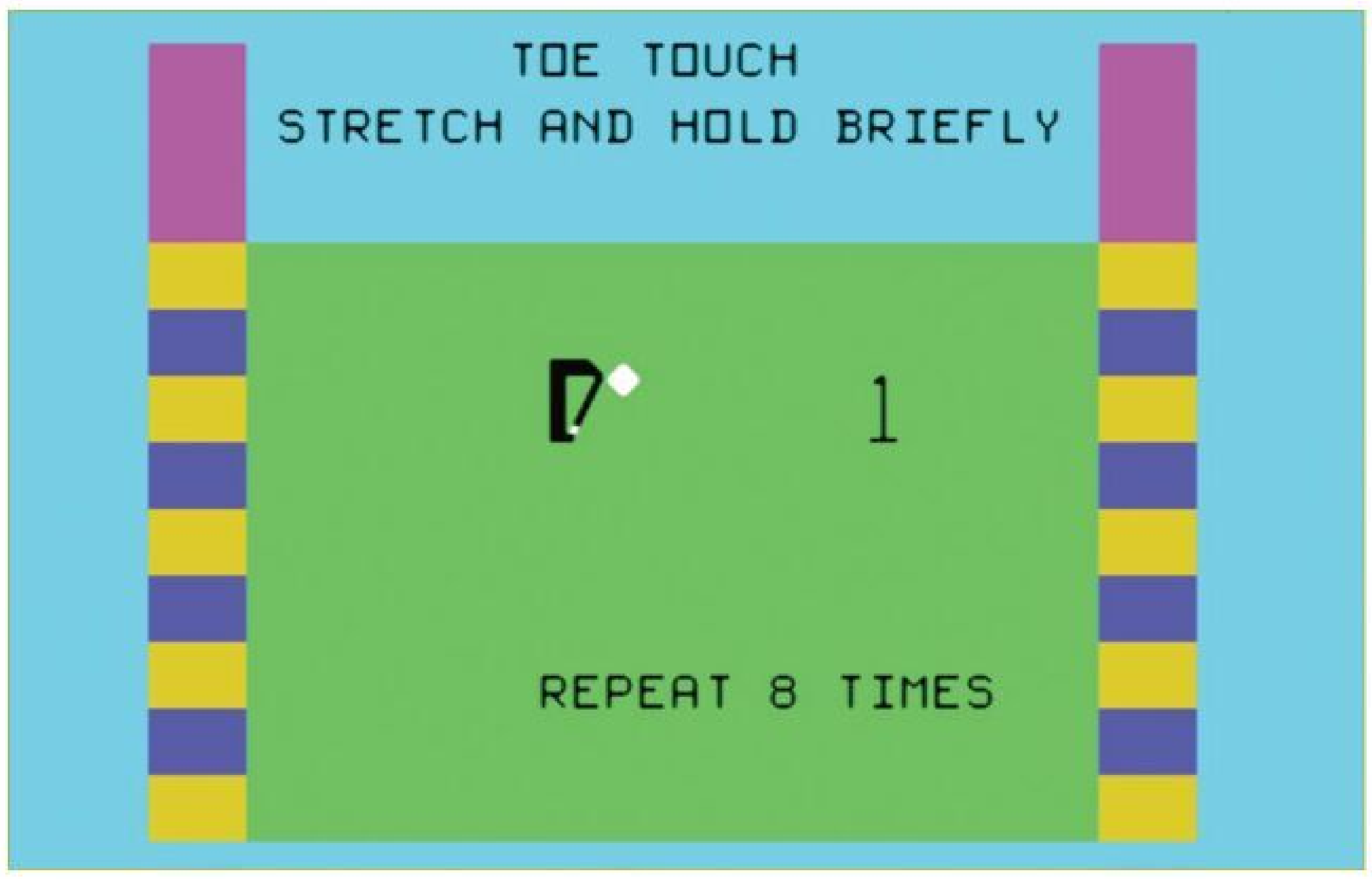
» Examples are *Alpiner* (1982), a mountaineering game, and *Parsec* (1982), a side-scrolling space shooter. For more general gaming recommendations, try *Hunt the Wumpus* (1980), *Tombstone City* (1981), *Space Bandits* (1983), and *Tunnels of Doom* (1982).

3 LEGACY

The TI-99/4A wasn't a financial success. TI was lured into a price war with Commodore, whose VIC-20 was cheaper to manufacture. Once TI price-matched Commodore, it was forced to sell the TI-99/4A at a loss, hoping to regain them through software licensing. This was the beginning of the end for the TI-99/4A.

» While Commodore was accommodating to developers, TI refused to release technical specifications to third parties, implementing a lockout system against third-party cartridges.

» By mid-1983, Texas Instruments announced a $100 million loss and retailers grew wary of the system. By Christmas 1983, the TI-99/4A was being sold from bargain bins for as little as $49. After selling 2.8 million units, the TI-99/4A was discontinued in March 1984, as the company moved towards IBM-compatible PCs.



TOE TOUCH
STRETCH AND HOLD BRIEFLY
1
REPEAT 8 TIMES

» The adorable Texas Instruments' demonstration cartridge would make a great background display at a LAN party.

Texas Instruments
TI-99/4A
TI Extended BASIC
Solid State Software

›› The shape of the TI-99/4A's cartridge bay and its hot electronics, earned it the nickname "coffee cup warmer".

FINDING SOFTWARE

Archive.org has a good software selection by the TOSEC team. If you need any more help or resources, www.99er.net is an excellent resource, along with www.ti99iuc.it, which has TI-99/4A games that can be played online.

Many games will require you to press either "Redo" or "Back". These are mapped to Alt + 8 and Alt + 9, respectively. See the Classic99 documentation for further key mappings.

4 EMULATION

There are several emulators for the TI-99/4A, but our choice is Classic99. It's open-source, has a simple interface, comes with cartridges, and doesn't require BIOS files.

›› Unfortunately, Classic99 is only available for Windows but works well through Wine. Emulators for Linux do exist, but Classic99 via Wine will still provide the most painless experience.

›› The Classic99 website provides a ZIP file via a link on the front page. Download and extract the ZIP file, then open the classic99 folder, which has the classic99.exe executable file. Once launched, Classic99 will open at the master title screen.

5 LOADING CARTRIDGES

Cartridges (called "command modules") are the easiest format to load. You can choose either from a selection in the Cartridge menu, or you can load cartridge files manually.

›› To load a cartridge manually, open the Cartridge menu and select User → Open. This will open a file browser, from which you can select your cartridge file.

›› Once selected, your emulator will reset to the master title screen, with the message "READY-PRESS ANY KEY TO BEGIN". Some cartridges will load straight away, while others give you the choice of 1, loading BASIC, or 2, loading the cartridge program.

6 LOADING CASSETTES

Cassettes are harder to load than cartridges but easier than disks. Classic99 supports WAV files for cassette audio.

›› For the best chance of loading, first load the Extended BASIC cartridge by choosing Cartridge → Apps → Extended BASIC.

›› When the emulator resets, press 2 at the boot prompt for Extended BASIC. At the BASIC prompt, enter the command:

```
> OLD CS1
```

›› From the main menu, choose Disk → Tape → Load/Rewind Tape. Select your WAV file from the file browser and click Open.

›› Press Enter for both the prompt that will say, 'REWIND CASSETTE TAPE THEN PRESS ENTER', and, 'PRESS CASSETTE PLAY THEN PRESS ENTER'.

›› You will now hear loading noise, followed by a beep once it has finished. It then says 'PRESS CASSETTE STOP THEN PRESS ENTER'. You don't have to press 'Stop Tape' in the Tape menu, but press Enter nonetheless.

›› Now at the BASIC prompt enter:

```
> RUN
```

›› If the gods are smiling, your cassette file has loaded.

7 LOADING DISKS

Loading disks on a TI-99/4A can be a nightmare. We didn't get file managers to launch executables but found a way of loading software from disk.

1. LOAD YOUR DISK IMAGE we'll use drive 2, as that gave us the best results. Click Disk → DSK2, then click the first menu entry. Then, choose your Disk Type from the drop-down menu, and click the button at the top-right corner to open a file browser. Click OK when you're done.

2. LOAD THE TI WORKSHOP CARTRIDGE, under Cartridge → Apps → TI Workshop (379). After the reset, press 2 at the boot prompt to load TI Workshop.

3. AT THE TI WORKSHOP MENU, press 3 for Disk Manager, followed by 1 for File Utilities.

4. AT THE DISK NUMBER PROMPT, enter your disk number: we're using 2.

5. IF IT HAS READ THE DISK IMAGE SUCCESSFULLY, write down the names of any programs, which will be marked by the column on the right.

6. INSERT THE EXTENDED BASIC CARTRIDGE, under Cartridge → Apps → Extended BASIC. Click Yes when prompted to change cartridge and reset the emulator.

7. PRESS 2 at the boot prompt for TI Extended BASIC.

›› At the BASIC prompt, enter the command:

```
> OLD DSK2.GOLF
```

›› We're just using GOLF as an example, but replace GOLF with whatever filename you wish to load.

›› After a brief pause, enter:

```
> RUN
```

SPECIFICATIONS

TEXAS INSTRUMENTS TI-99/4A (1981)

CPU:	TI TMS9900 @ 3 Mhz
RAM:	16KB, 256 bytes Scratchpad RAM
Graphics:	TMS9918A chip – 16 colors @ 256 x 192
Sound:	TMS9919 or SN94624 chip, 3x voices, 1x noise
OS:	TI BASIC
Storage:	Cartridge, cassette, 5.25-inch floppy
Released:	June 1981
Launch Price:	$525
Worldwide sales:	2.8 million

FUEL
000100
LIFT 3
TOP 000000

›› Parsec is one of the TI-99/4A's best titles. Its extensive voice synthesis was ahead of its time for rival '80s micros.

© WIKIMEDIA

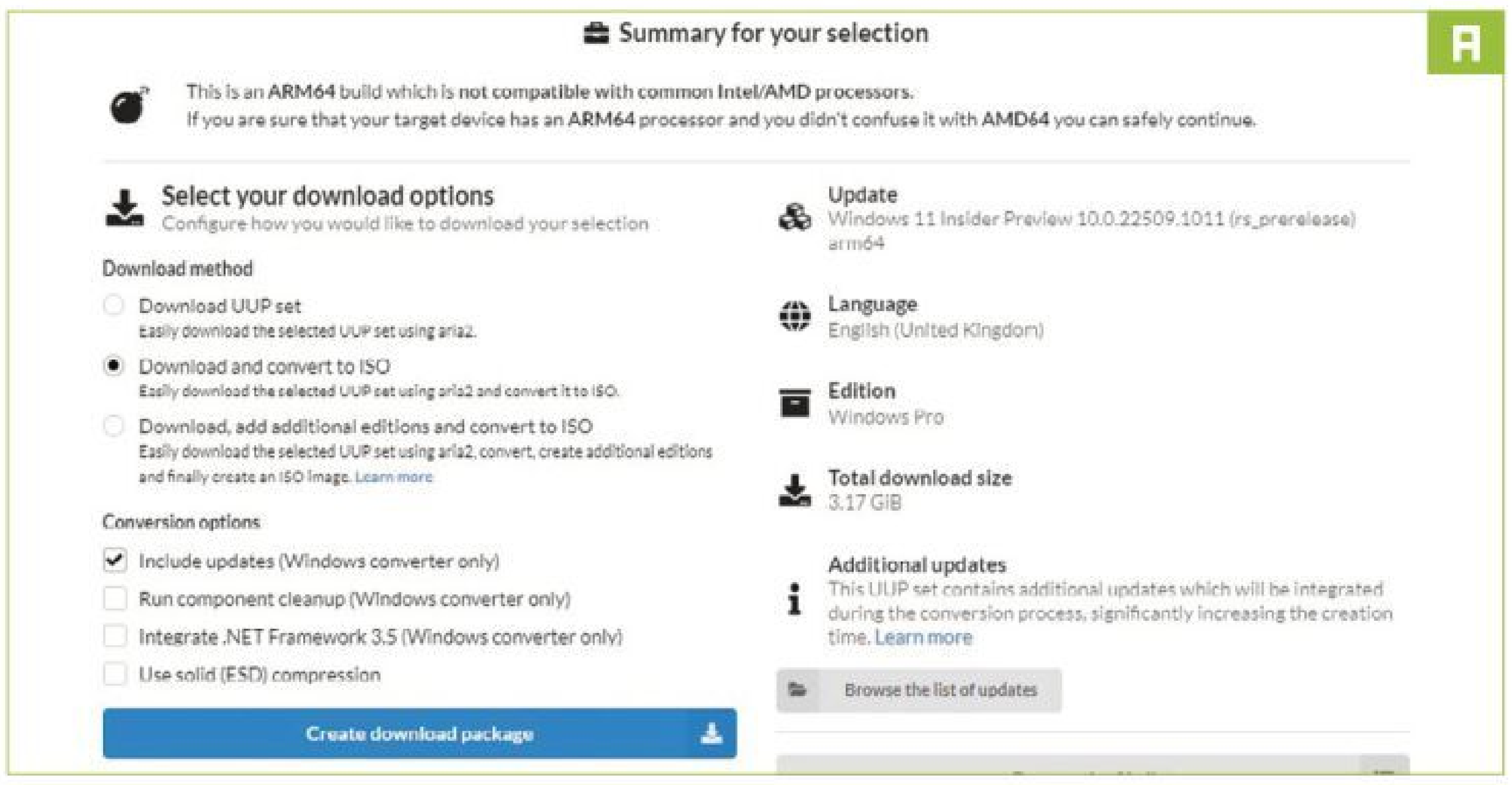
Run Windows 11 on a Raspberry Pi 4

YOU'LL NEED THIS

A RASPBERRY PI 4 (4GB OR 8GB RAM)
Internet connection
Spare flash drive
Infinite patience

THERE'S NOTHING WRONG with the Raspberry Pi OS. But it is a bit basic and smells of Linux. So why not replace it? There are desktop options, such as Ubuntu, RISC-OS, and RaspBSD; gaming options such as RetroPie and Lakka; and media center choices such as OpenELEC or OSMC. And then there's Windows. Or rather, there isn't. While a version of everyone's favorite operating system exists that will run on the Pi's ARM architecture, it's neither readily available nor officially compatible. However, you can still get it to run on the accommodating little board.

With Windows 11 bedding in, it's time to upgrade both software and method to get Microsoft's latest and greatest running on the Raspberry Pi 4. It's not perfect—you won't get any life out of the Pi's onboard Bluetooth, Wi-Fi, or GPIO pins. Audio doesn't work over HDMI, and you get the occasional 'pop' through the headphone jack. The Ethernet port and all the USBs do work, however, so if you aren't near a wired internet connection, a USB wireless adapter can be pressed into service. **–IAN EVENDEN**



Summary for your selection

This is an **ARM64** build which is **not compatible with common Intel/AMD processors.**
If you are sure that your target device has an **ARM64** processor and you didn't confuse it with **AMD64** you can safely continue.

Select your download options
Configure how you would like to download your selection

Download method
○ Download UUP set
Easily download the selected UUP set using aria2.
● Download and convert to ISO
Easily download the selected UUP set using aria2 and convert it to ISO.
○ Download, add additional editions and convert to ISO
Easily download the selected UUP set using aria2, convert, create additional editions and finally create an ISO image. Learn more

Conversion options
☑ Include updates (Windows converter only)
☐ Run component cleanup (Windows converter only)
☐ Integrate .NET Framework 3.5 (Windows converter only)
☐ Use solid (ESD) compression

Create download package

Update
Windows 11 Insider Preview 10.0.22509.1011 (rs_prerelease) arm64

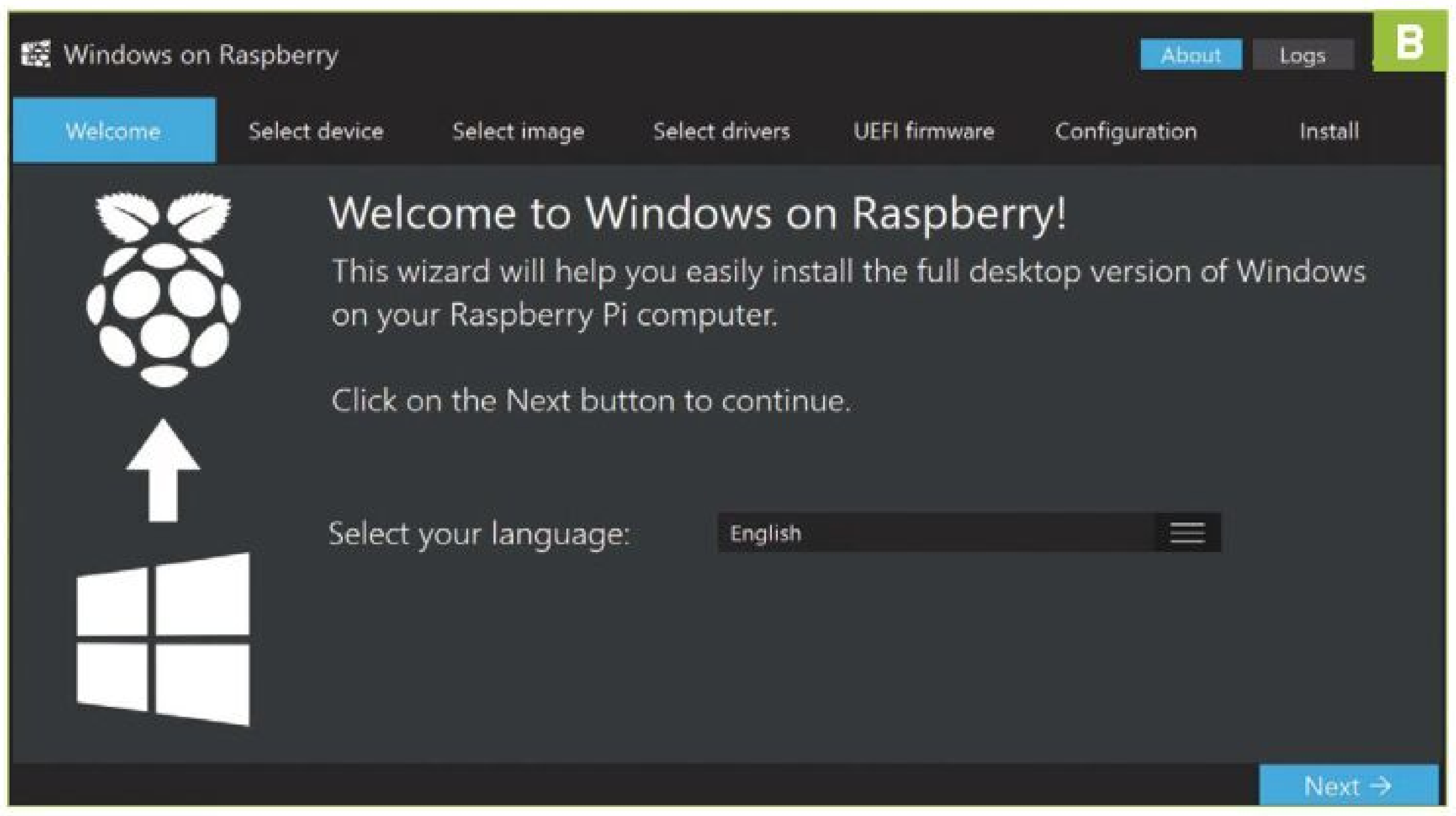
Language
English (United Kingdom)

Edition
Windows Pro

Total download size
3.17 GiB

Additional updates
This UUP set contains additional updates which will be integrated during the conversion process, significantly increasing the creation time. Learn more

Browse the list of updates



Welcome to Windows on Raspberry!
This wizard will help you easily install the full desktop version of Windows on your Raspberry Pi computer.

Click on the Next button to continue.

Select your language: English

1 PREPARATION

Format your micro SD card, or whatever external drive you're going to install Windows on. It will be reformatted as FAT32 during the copying process, but this step just blanks it off and means you're more likely to look at its contents for anything you might want to keep. Download the Windows on Raspberry Imager from https://www.worproject.ml/downloads (version 2.2.2 is now available) and extract the zip into a folder on your desktop called something like Win11—the important thing is that there are no spaces in the name.

2 GET AN ISO

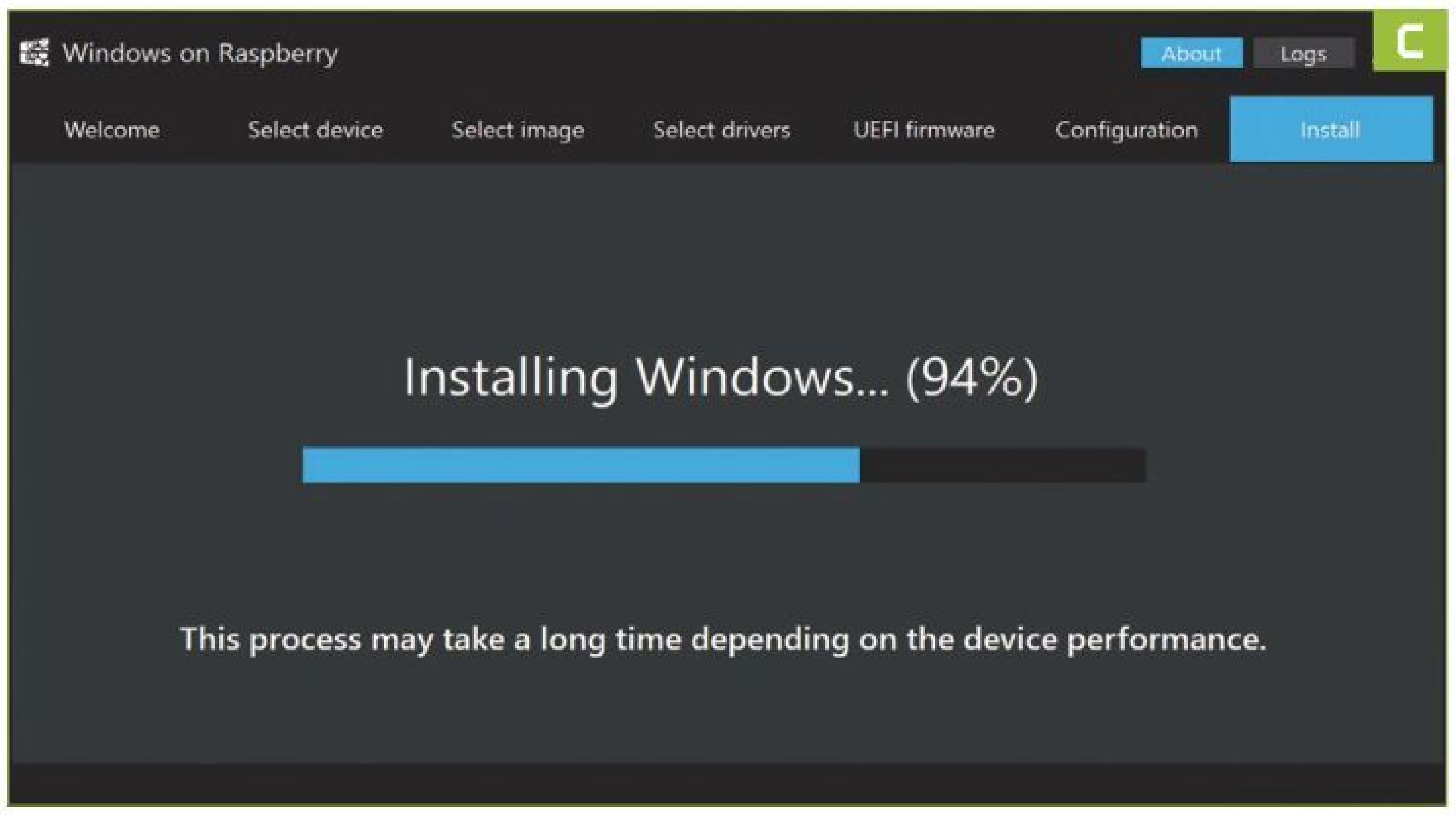
Obtaining a Windows 11 ARM ISO isn't quite as straightforward as getting an X86 build. Point your browser to https://uupdump.net/ and look for a Windows 11 Insider Preview for the ARM64 architecture—a beta build if you can see one, they are more stable than the dev channel builds. Click on it, select your language, choose a version (either Home or Pro), and click Next. On the next screen, choose "Download and convert to ISO" then click "Create download package" [**Image A**]. A small zip will download. Extract it, and run the uup_download_windows.cmd file as an Administrator. This will trigger all sorts of security warnings but choose Run Anyway.

3 WAIT

The next step takes a while, depending on the speed of your PC and the fatness of your internet pipe. The script you just ran instructs an open-source multi-connection download service called Aria 2 (https://aria2.github.io/) to download the files necessary for installing Windows 11 on ARM and processing them into an ISO file. You'll find it in the Win11 folder you created once the process is finished (you'll be prompted to press '0' to exit). Ours is 5.2GB in size.

4 WOR

Open the Windows on Raspberry folder and run WoR.exe [**Image B**]. Select your language, then the device you'll be installing on—Pi 2, 3, 4, or 400 (we'd recommend a Pi 4 or 400, and then rather than installing the OS onto an SD card, put it on a USB-connected SSD of some sort). To make your Pi bootable, you'll need to have updated to the latest version of the bootloader. If you're not sure how to do this see Boxout 2. Choose your Pi and



Installing Windows... (94%)

This process may take a long time depending on the device performance.

© RASPBERRY PI FOUNDATION

A NOTE ON BULLSEYE

Last month, we showed you how to upgrade your Pi to the newest release of its Linux operating system, known as Bullseye. The launch of a new OS is an exciting time, so forgive us for not underlining hard enough that Bullseye wasn't ready for general release. In fact, it broke a lot of things, especially if you like using cameras with your Pi.

Raspberry Pi took the unprecedented step of issuing a new OS build, Raspberry Pi OS Legacy, that rolls back to the previous Buster release. It fixes a lot of problems and removes the hardware-accelerated build of the Chromium browser, replacing it with an upstream software-accelerated variant. Missing camera interfaces are also reinstated through an option in the Raspi-config app.

We're assured Bullseye is the future and, once the 32-bit build is fixed, a proper 64-bit build for Pi 3 and 4 models, especially the Pi 4 8GB, will be next.

the target drive, then click Next. On the next screen, you'll need to find your ISO. Point it to the file, or drag and drop, then wait for a moment while it mounts. Click next, then choose the latest package of drivers (the recommended option) when prompted. Accept the license agreement, then hit Next. For the firmware, choose the recommended option of the latest available. There will be a short break for a download and then press Next again. You'll then see a configuration overview. Press Next if you're happy, and Install on the next page. Sit back and wait [**Image C**].

5

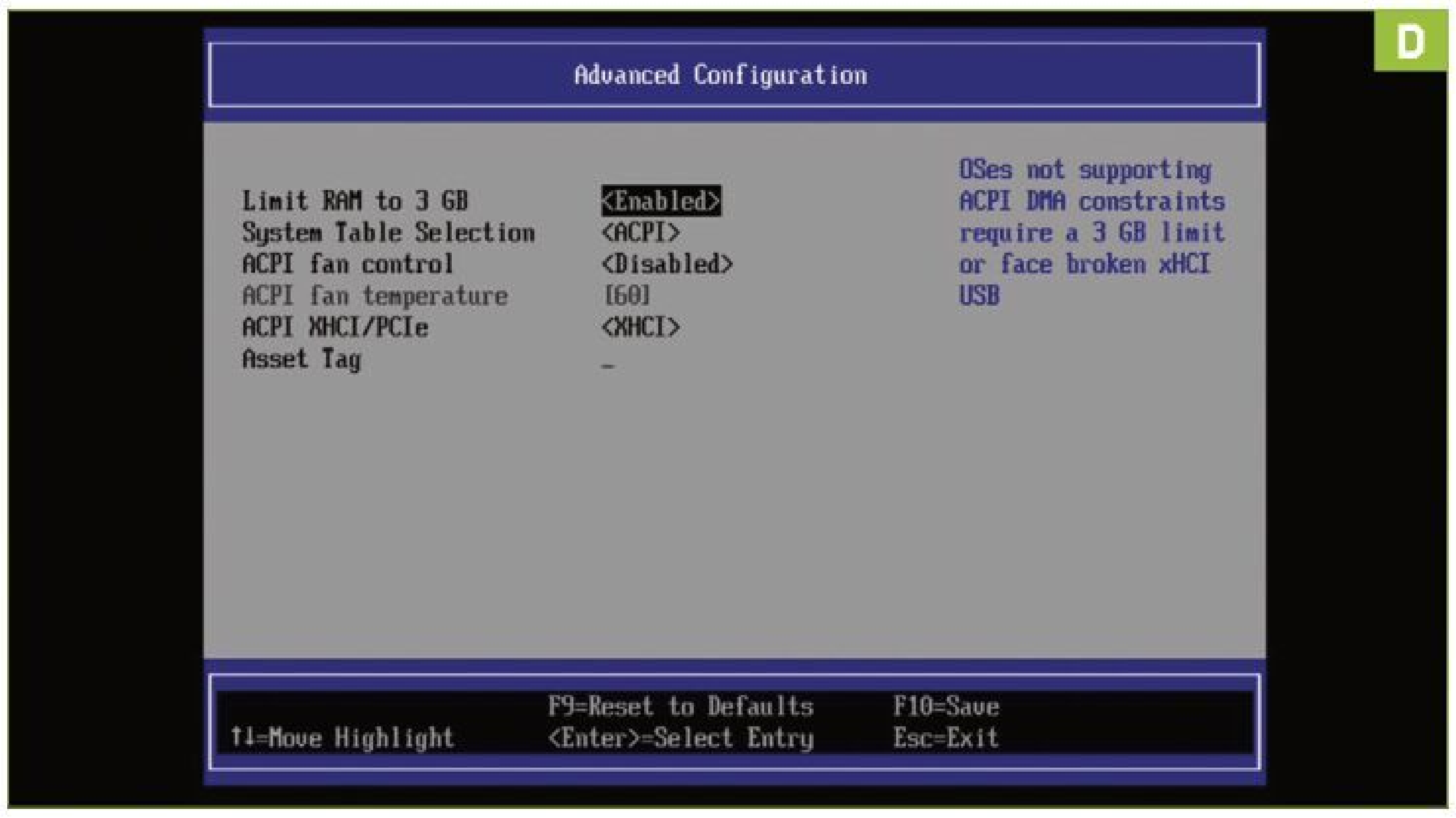
START AGAIN, MAYBE?

This is far from a foolproof process. Our first attempt stalled at 81 percent, then refused to re-mount the ISO once we'd quit and reopened the app without a complete restart of our PC. We discovered another script in the same folder that cleared out the remains of mounted images, and this (run as an Administrator) allowed the process to begin again. We ended up running the Aria 2 script again, this time choosing Windows 11 Home over Pro, and trying to install it on a different drive. Eventually, we were successful.

6

BOOT

Put the USB drive into one of the blue USB 3 ports on your Pi, make sure there's nothing in the microSD card slot, and switch it on. Almost immediately, we saw a raspberry logo and the familiar swirling Windows circle of dots. It stayed on 'Getting Ready' long enough for us to start thinking something else had gone wrong. Eventually, it dropped to a plain black screen, which did little to help, but the raspberry logo soon returned and, after being asked to wait 'just a moment', the Windows logo appeared and we began the setup process. Another reboot later and we signed in with a Microsoft Account, went through the privacy nonsense, and eventually got a desktop. You don't need an image for that, surely.

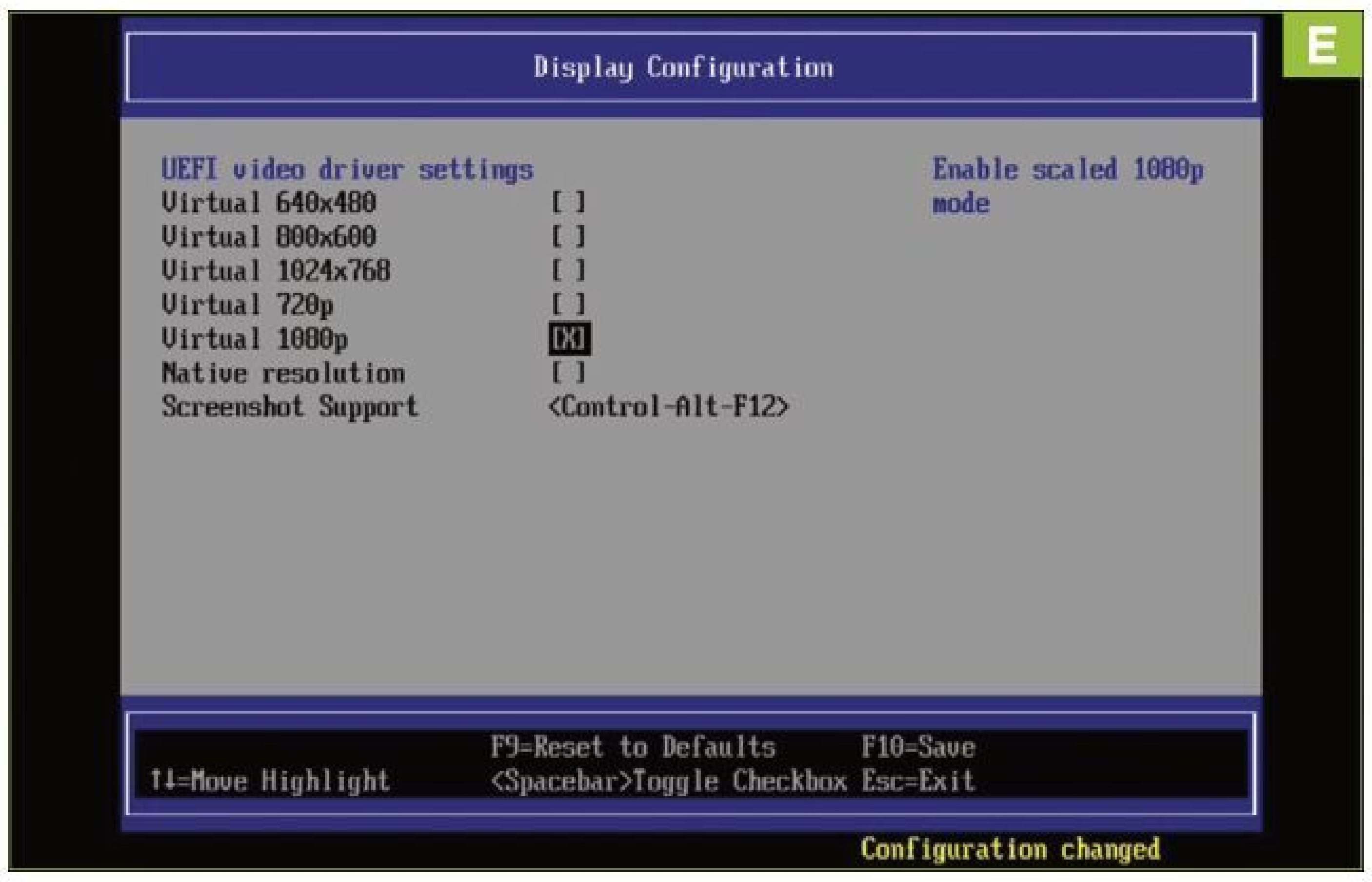


```
                    Advanced Configuration

Limit RAM to 3 GB         <Enabled>         OSes not supporting
System Table Selection    <ACPI>            ACPI DMA constraints
ACPI fan control          <Disabled>        require a 3 GB limit
ACPI fan temperature      [60]              or face broken xHCI
ACPI XHCI/PCIe            <XHCI>            USB
Asset Tag                 _

                    F9=Reset to Defaults   F10=Save
↑↓=Move Highlight   <Enter>=Select Entry   Esc=Exit
```

© MICROSOFT



```
                         Display Configuration

UEFI video driver settings                      Enable scaled 1080p
Virtual 640x480          [ ]                    mode
Virtual 800x600          [ ]
Virtual 1024x768         [ ]
Virtual 720p             [ ]
Virtual 1080p            [X]
Native resolution        [ ]
Screenshot Support       <Control-Alt-F12>

                    F9=Reset to Defaults      F10=Save
↑↓=Move Highlight   <Spacebar>Toggle Checkbox Esc=Exit
                                       Configuration changed
```

7

TWEAKS

Restart your Pi and press Esc when prompted to enter the boot menu. Your Pi is being limited by default to 3GB of RAM—for owners of 8GB models, this will not do, and even 4GB would be an improvement. The firmware menu is neatly set out, but don't be tempted to use the easily accessible CPU frequency settings to attempt a spot of overclocking—it won't boot if you fiddle with this. What you want is under Device Manager: Raspberry Pi Configuration → Advanced Configuration → Limit RAM to 3GB [**Image D**]. Change this from enabled to disabled, then save and exit, and you'll get a much snappier Windows experience on an 8GB Pi.

8

IN USE

Don't go expecting this to be anywhere near as speedy as on an Intel chip. Right-clicking the desktop brings it out in a sweat, the spinning cursor visible for a long time before the menu pops up. Clicking on the shortcut for an Explorer window leads to a five-second wait before it appears, and the screen resolution seems stuck at 1280x1920, which isn't the native resolution of any monitor we own (this can be changed in the firmware, Device Manager → Display Configuration, forcing it into 1080p [**Image E**]). This is definitely a curio rather than an operating system you'll want to use every day, even with 8GB of working RAM. ⏻

UPDATE YOUR PI

The easiest way to update a Raspberry Pi is by using the Terminal. Open the app, and type "sudo apt update" to discover what needs updating, then "sudo apt full-upgrade" to carry out the updates. This procedure also updates the Linux kernel and system firmware when there are new versions available. A quick reboot after the updates are done will have your Pi running at the best of its capacity.

To update the bootloader, open Terminal and type "sudo raspi-config" to open the configuration app. Choose Advanced Options, then Bootloader version. If this says Default, change it to Latest. Close the app and reboot. Your Pi will now be capable of booting from USB devices and the microSD card. To boot from USB, remove any bootable microSD cards, otherwise, the Pi will prioritize the card.

Stepping into music production

YOU'LL NEED THIS

WINDOWS 8.1, 10 OR 11
At least 4GB RAM, at least 4GB free disk space

OVER THE PAST DECADE, the way we listen to music has fundamentally changed. No longer tied to physical forms, such as vinyl discs, cassettes, or CDs, downloading and streaming services have taken music collections away from our shelves and placed them on our desktops.

The rise of digital audio is largely responsible for this change. Products such as the original Sony Walkman and the Apple iPod delivered music on the go, but these were eventually superseded by the smartphone, which can now deliver many thousands of music tracks all day, every day, from your rucksack or pocket, making music more accessible than ever.

The same can be said for music production. Whereas once you needed a band or an orchestra of musicians playing instruments, studio time, and expensive recording equipment, these days it is possible to produce a song, publish it, and listen to it from the comfort of your desktop. With a smartphone and software, you can even do this from the palm of your hand.

Here, we will take a look at how music production has changed over the years, the software you need to get started, and how you can compose your own musical masterpiece. **–SAM LEWIS**

1 THE DAWN OF THE DIGITAL AUDIO AGE

Before we go any further (well, backward technically) we first need to understand the fundamental elements of the digital audio workstation (DAW). Pretty much most music you hear these days will have been composed or produced in some way with the help of a DAW. Thanks to its ease of use, format, efficiency, and productivity, this technology has superseded most other traditional methods of music production. When it's this easy to produce music, it just makes sense to go down the route of DAWs.

›› So then what is it? A DAW is a piece of software that lets you manipulate audio recordings in a multitude of different ways. A DAW lets you record audio, loop, compose, sample, edit, master, mix, and more. You can use it to create music, master audio for video production, commercials, YouTube videos, you name it [**Image A**]. The possibilities are endless.

›› In its simplest form, a song is simply a layering of sounds in a specific order. A DAW lets you control the layering and allows you to choose the order of sounds.

© TECHIVATION ON UNSPLASH

›› To understand how DAWs came to be, we will take a step back to the mid-1970s. Newly formed, and later to be industry giants, Soundstream made a huge mark on the audio world. Based in Salt Lake City, Utah, the company was one of the first digital audio recorders in the USA. It played a massive role in developing digital audio recording, editing, and producing, despite competition from rival 'audiophile' companies.

›› The mark Soundstream left behind still influences audio production to this day. For producers of the time, the introduction to a more digital style of work was a huge technological change to their workflow and the whole industry. The tools that came with the shift to digital production were groundbreaking at the time and paved the way for audio production to come.

›› Soundstream was founded by Dr. Thomas G. Stockham Jr. in May 1975 at the University of Utah. Stockham wanted a solution to the issues he was having with analog audio at the time. He essentially wanted the ability to remove distortion, background noises, and general unwanted sounds that could creep into recordings, but in a more efficient way.

›› In 1962, Thomas, using a TX-0 computer and an 'analog-to-digital' converter, began creating digital audio tape recordings whilst studying at MIT (Massachusetts Institute of Technology). As digital audio is binary data, when it's transferred to tape it isn't subject to the issues Thomas was facing with traditional analog audio, such as the distortion he was encountering.

›› By the late 1960s in Japan, engineers at the NHK television broadcasting network had created a fully working stereo recorder featuring two channels. This had a sampling rate of 32kHz and 13-bit resolution.

›› At the start of the 70s, Japanese audio company Denon had used this recorder to produce the song *Something* by Steve Marcus. This was the first digitally-recorded, commercially-released track. Denon then created the DN-023R, an eight-channel recorder with the same 13-bit resolution but a larger sampling rate of 47.25kHz.

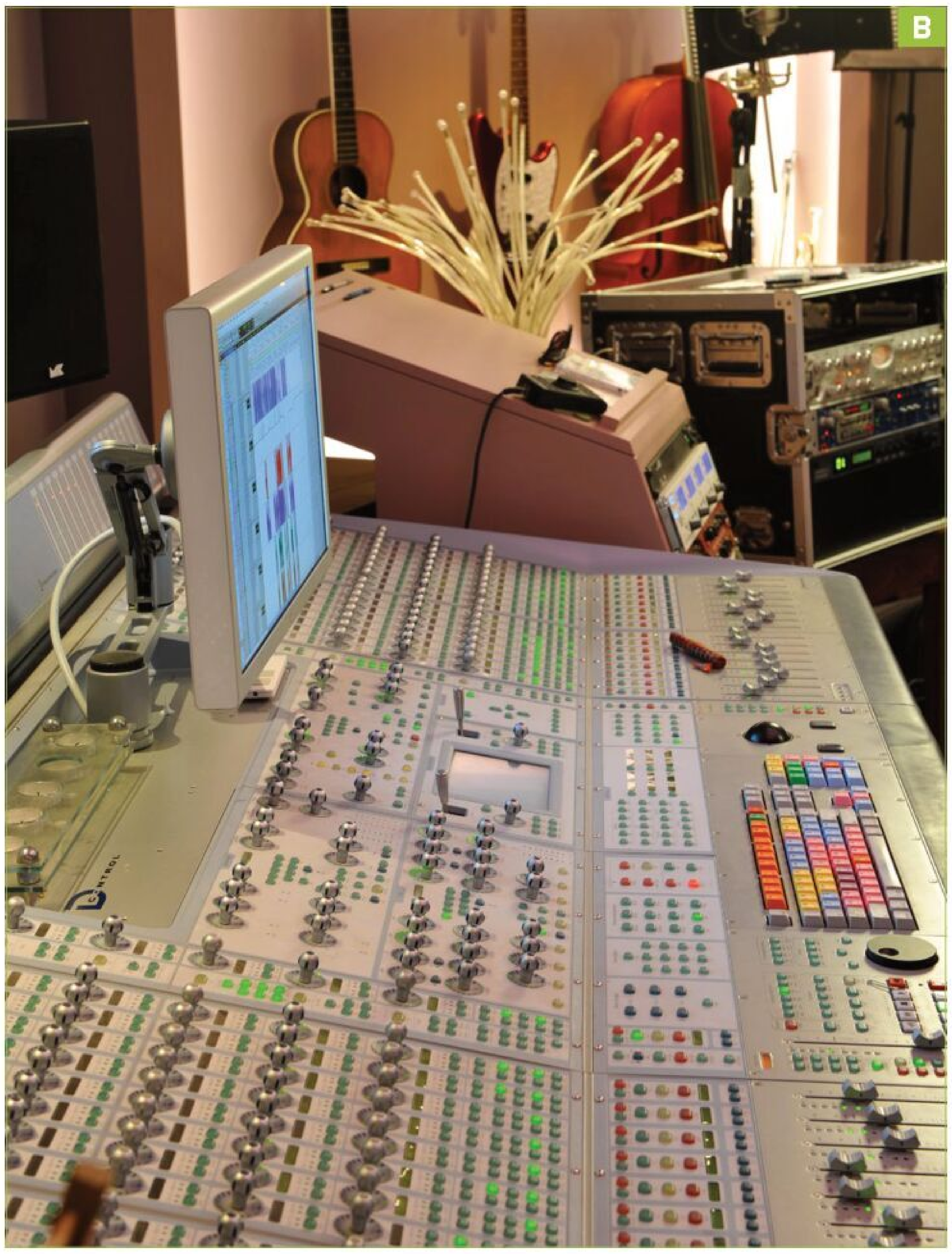
›› By 1975, Stockham had begun working on Soundstream's first digital audio recorder prototype by designing the architecture for the device. His team consisted of electrical engineers and computer scientists that helped spark this idea into life. Jules Bloomenthal joined as a technician in September that year, and he helped build a computer interface for the machine. This would allow for the transfer of digital audio data in real-time between a computer and a recorder.

›› The machine contained an instrumentation tape drive by Honeywell that was commercially available at the time. There was also an analog-to-digital and digital-to-analog ('A-D/D-A') converter and tape encoding and decoding electronics inside too. A Digital Equipment Corporation PDP-11/60 computer was used for the editing with this machine.

›› The digital audio was stored on two RP04 disk drives that were connected to this computer. The computer would then run Soundstream's software called 'DAP', which stands for digital audio processor. This could perform basic edits, such as cross-fades and splicing by using a text terminal. This machine was the precursor for modern DAWs and the principle has stayed true to this day, just with a bit more convenience.

›› The problem at the time, and for the ensuing years, was making this commercial. The process required large amounts of fast storage and, back then, this was quite the struggle.

›› By the end of the 1980s, the technology was evolving at a rapid rate and the popularity of home computers such as the Apple Macintosh, Commodore Amiga, and Atari meant that storage concerns were less of an issue. Companies such as Digidesign and Macromedia began developing applications that could edit audio samples and perform two-track CD mastering.


B

›› In 1994, four-track editors came along, this saw companies such as Pro Tools, and the first Windows-based DAWs come into life. By 1996, 32-track DAWs were readily available and year after year they continued to get more detailed, faster, and more capable, becoming the industry standard recording system [**Image B**].

›› DAWs have given the ability to allow anyone to produce and create music and it's thanks to the initial development from companies such as Soundstream that allowed this to happen.

2

THE COMPONENTS

Of course, you will need either a PC or a laptop to run your DAW and hook all of your equipment up. It isn't necessary to have a crazy, powerful machine that runs ridiculous numbers, however, the faster the PC [**Image C**], the more processing it will be able to handle. You will soon realize that your music composition projects can get pretty intensive.

›› For FL Studio, the minimum requirements for the Windows application are; Windows 8.1 and above, at least 4GB of free disk space, and 4GB of RAM. On the FL Studio website, it states that 'the more powerful your CPU, the more instruments and effects you can use—and they aren't wrong.

DAW

We have already spoken about DAWs, but choosing a good one is essential to you feeling confident when producing music or any form of audio. So what is the best DAW to choose to start with? It's hard to give a definitive answer to this question, as with many applications, it takes some trial and error to find the one you like.

C

» All DAWs will provide you with enough tools to create a similar end goal [**Image D**]. The good thing about the majority of them is that they will provide you with either a demo or a free trial to test them out. We recommend picking one with a clean interface as heading into a new piece of software can be pretty overwhelming. Also, this is where the real estate from a dual monitor setup or an ultra-widescreen will come in handy.

» To make life a little easier when starting and to keep organized, you want as little clutter as possible. Interface-wise, we recommend trying FL Studio to get into the world of audio production. It has a colorful, clean, and intuitive UI that should help inspire some creativity.

STUDIO REFERENCE HEADPHONES/MONITORS

Hearing the most accurate and purest version of your project is the best way to get the most honest result. Using studio reference devices can allow you to distinguish details that other peripherals may not pick up, so you can tweak to even deeper depths.

» Although the term 'studio' is often thrown around lightly, true studio headphones or speakers still hold value. They are created with the intention of being used in the recording studio or your home office. We recommend opting for headphones first as they are often the more affordable option [**Image E**].

» True studio headphones shouldn't leak sound when recording. If you are singing/playing an instrument whilst listening to a guide to follow along with, the last thing you want is for the microphone to pick up any headphone leakage. These will most likely be a closed-back design.

» Of course, you also want them to be comfortable and durable if you are using them for long periods. However, the most important factor here is the sound quality. Studio headphones are designed to reveal flaws in your recordings and generally deliver a more neutral flat soundscape for this reason.

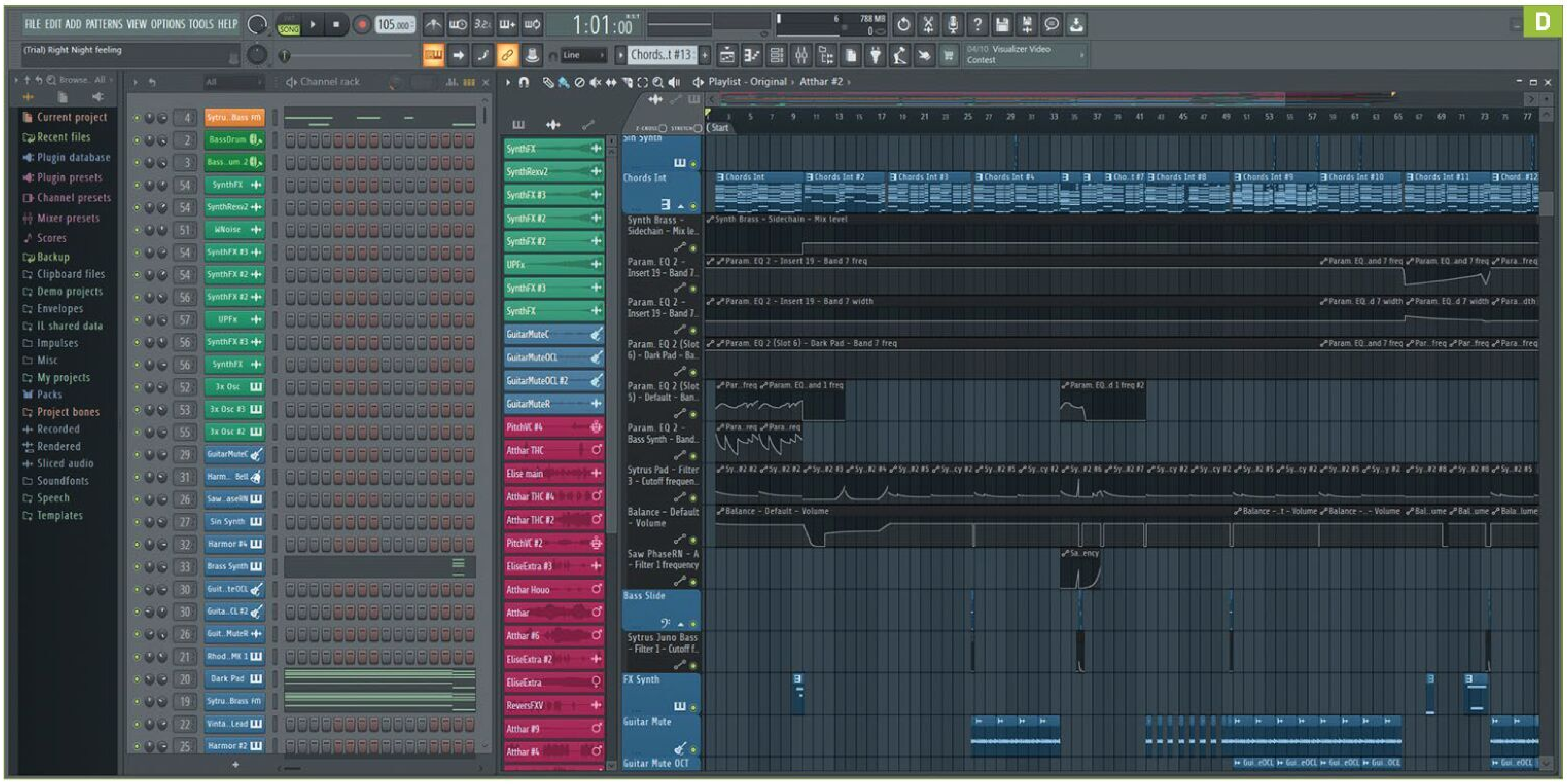
MIDI CONTROLLER

MIDI stands for musical instrument digital interface and a MIDI controller [**Image F**] essentially connects physical hardware to the software. This can be used to virtually play instruments and sequence audio files on your DAW.

» You can use this device for pretty much anything, it works as a universal controller that will play whatever you tell the DAW to play. For instance, you could load one button or key on the MIDI to play a specific drumbeat.

» A MIDI makes workflow incredibly efficient because of how flexible it is. Typically, they feature keys, a drum pad, and some dials.

» If you decide to purchase a MIDI controller, AKAI produces some great introductory mini-models that should get your creative juices flowing.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FX Synth
Guitar Mute
Guitar Mute OCT

D

© WWW.IMAGE-LINE.COM

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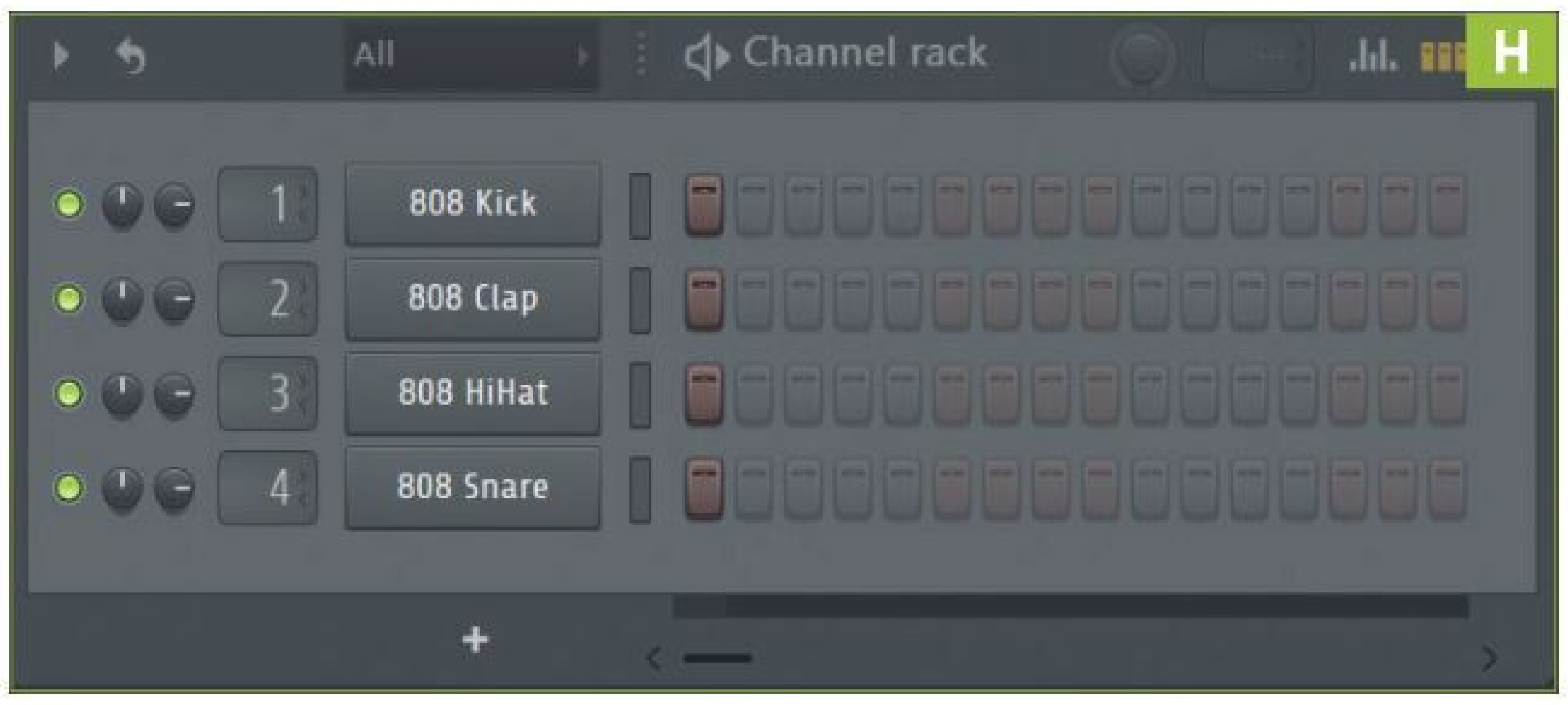
H
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Channel rack
1
808 Kick
2
808 Clap
3
808 HiHat
4
808 Snare
+

3

FL STUDIO 20 INTRODUCTION

In this mini-tutorial, we will look at the main segments of the FL Studio DAW and how to get started when creating an audio project. This should give you an understanding of how this application works, its layout, and its functionality. Hopefully, by the end, you'll be able to have a crack at your own project and see if you can piece together a basic production.

» On the face of it, this may look a little scary, but when you break it down, it should help you feel at ease with this DAW and others. Songs are constructed by layering different sounds on top of each other and putting them all together. Think of it as a cake, with the layers providing a well-rounded taste.

» To get to grips with FL Studio, we start with a blank canvas. There are four essential elements of this software that are the fundamental building blocks.

BROWSER

On a standard layout of FL studio, the browser can be found on the left-hand side of the UI [**Image G**]. This is where the sounds, instruments, and samples are going to be stored for your projects. It is well organized and easy to navigate around, which helps with efficiency. Like most projects, clear organization is key to a good workflow.

» To find a drum beat sound, you can head into the pack's menu, then drums and you will have an array of pre-installed samples to choose from. You can always add your own recordings into your work and use the browser tab to locate them. To do this, head up to options in the top tab, file settings. Then in the 'browse extra search folders' pop-out window click on a folder icon to find the folder you want to bring into your project.

CHANNEL RACK

Once you have found a sample you are happy with, simply click and drag this over to the channel rack window. Thankfully in FL Studio, everything is named clearly, which helps with efficiency.

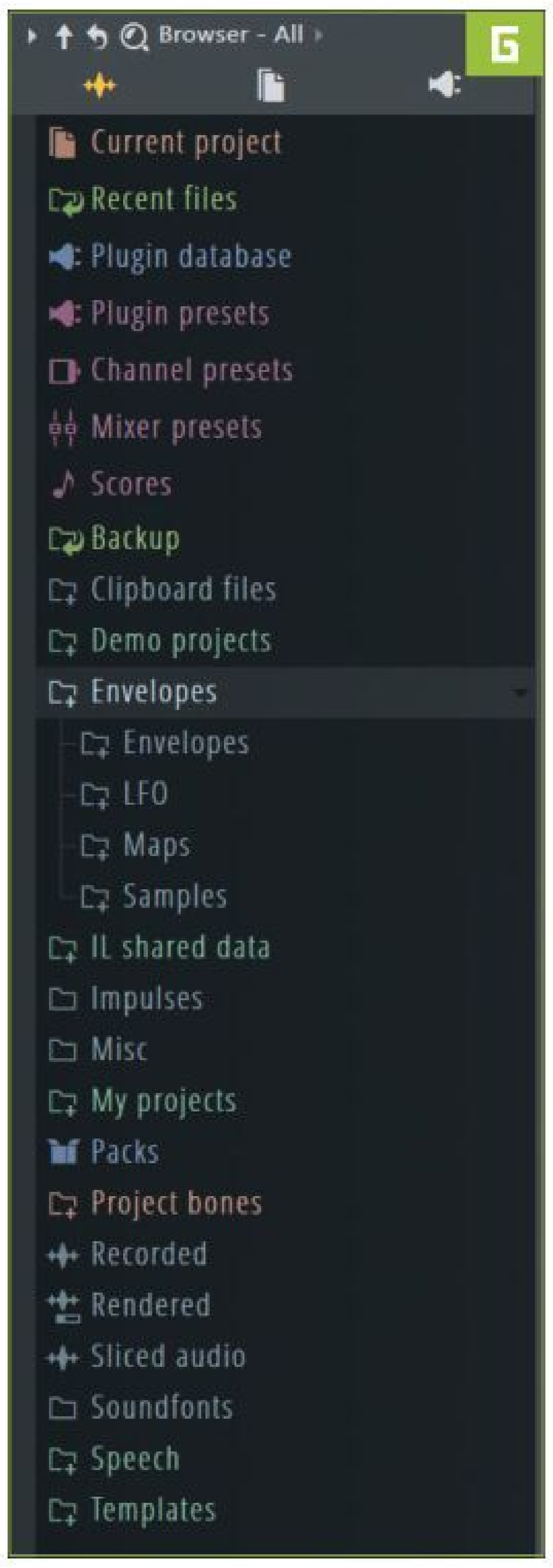
» The channel rack is one of the most important windows in this DAW and is where all your channels are kept. If you click on a channel name in the channel rack, it will open up another window in which you can fine-tune your sample. Some of these tunings include stretching, pitching, reversing, crossfading, and more.

» Each channel has a green button next to it. When you click on this, it will mute the specific channel [**Image H**]. Next to the green button are two dials, the first for panning and the second for volume. To remove a channel from the rack simply right-click, then delete. The numbers on each row relate to the mixer channel that the sample is being sent to.

» Finally, next to the name in the channel is the 16-step sequencer, indicated by a row of tiny rectangle icons. This is an easy way to create a loop, click some of these sequences then hit the spacebar to hear your loop play through.

» At the top of your screen on the left of the play and stop icons are buttons for pattern and song. Whatever is clicked is whatever will play, make sure the 'pat' button is selected to hear your loops.

» Experiment by bringing different sounds into the channel rack, using multiple channels and various sequences to create a simple beat.


G
Browser - All
Current project
Recent files
Plugin database
Plugin presets
Channel presets
Mixer presets
Scores
Backup
Clipboard files
Demo projects
Envelopes
Envelopes
LFO
Maps
Samples
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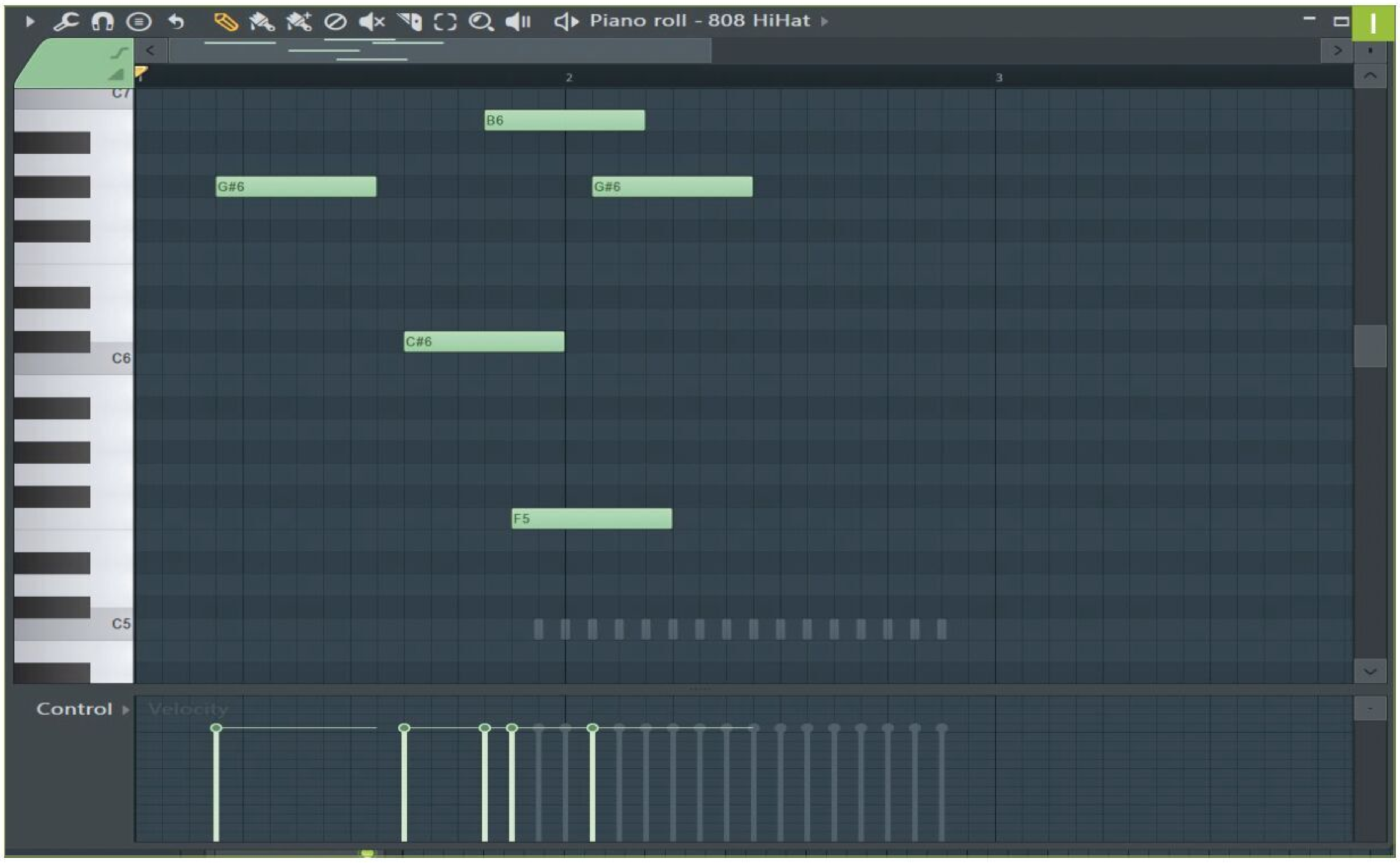
Impulses
Misc
My projects
Packs
Project bones
Recorded
Rendered
Sliced audio
Soundfonts
Speech
Templates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Piano roll - 808 HiHat
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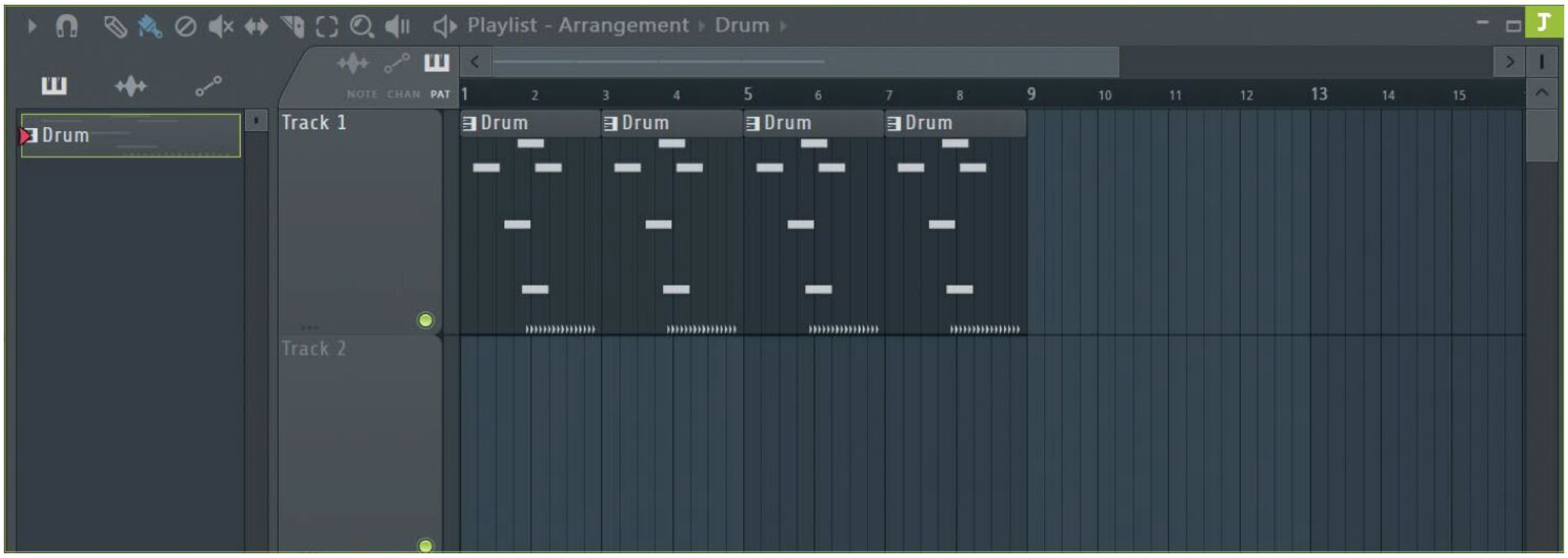
3
C7
C6
C5
B6
G#6
G#6
C#6
F5
Control
Velocity



PIANO ROLL
In this section, you can take the channel notes and go into a lot more detail. Here, you can compose and edit MIDI notes from a channel. MIDI is a software language that allows your computer, a MIDI controller, and other instruments to communicate with each other. When creating audio on a MIDI controller, it can be easily manipulated at a later date if you make a mistake. Whereas if you hit the wrong string on a guitar whilst recording, chances are you may have to re-record a whole piece of the music.

›› To open up the piano roll, right-click on any channel name in the channel rack and click 'piano roll' from the list. Now we can create melodies by left-clicking to add notes and right-clicking to remove them. To change the duration of the notes, drag on the edge to shorten or lengthen [**Image I**].

›› You can also drag notes around to put them precisely in place. Keep pressing the spacebar to play through the pattern you have created, it should loop this sequence.

›› At the top, there are tools such as the slice tool to chop up notes, the mute tool, and the rectangle tool that allows you to select multiple notes at once. At this stage, try experimenting and see if you can come up with a fun little MIDI sequence of your own to create a melody.

PLAYLIST WINDOW
Hopefully, at this stage, we now know how to create basic drum patterns in the channel rack and MIDI melodies in the piano roll. The playlist window [**Image J**] is where you bring the elements together to create a complete

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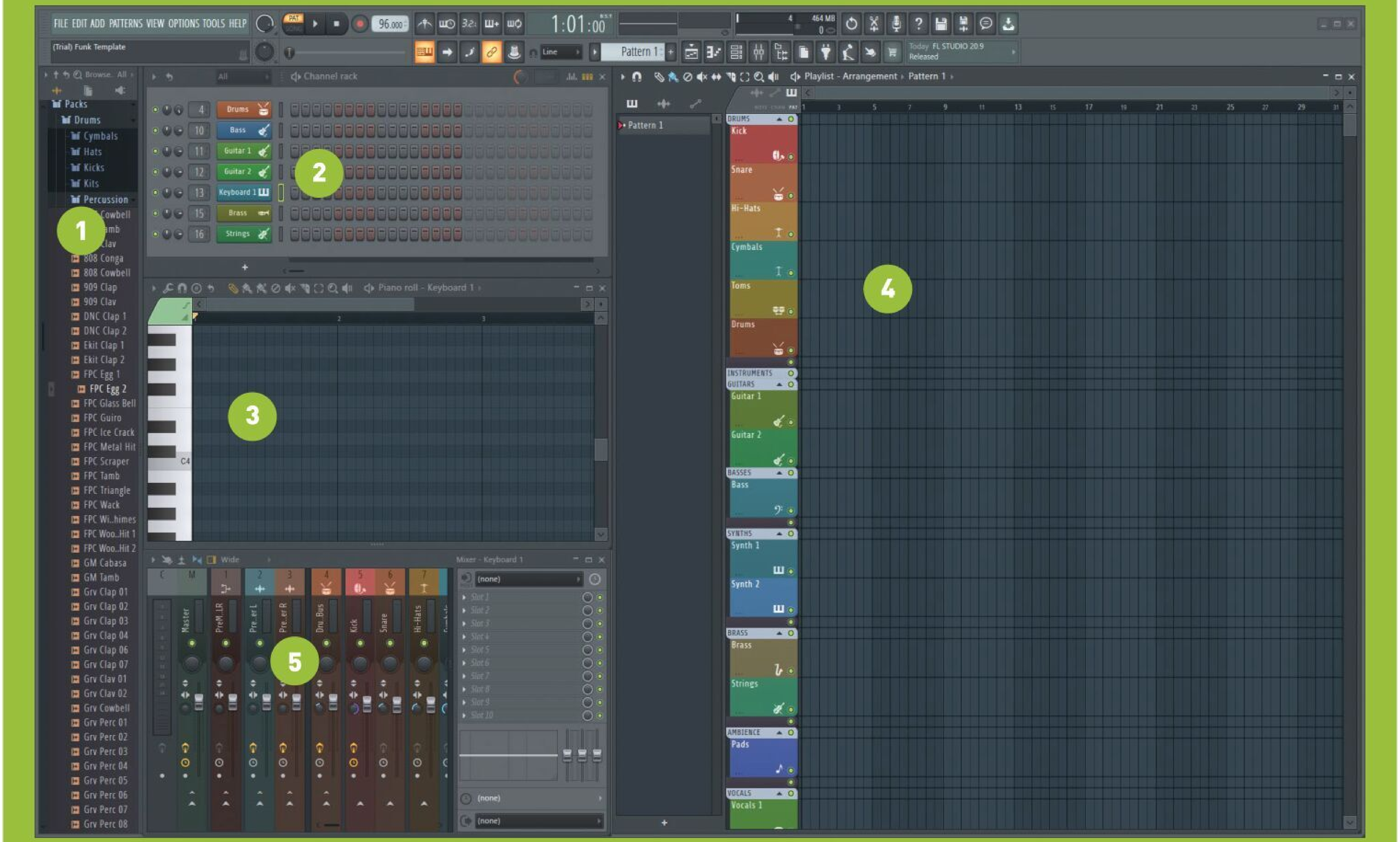
FL STUDIO 20 USER INTERFACE



1. BROWSER
This is the place to find samples, beats, instruments, and your imports.

2. CHANNEL RACK
The channel rack holds all of your chosen instruments and is where you can make loops and sequences.

3. PIANO ROLL
Use the piano roll to create unique sequences. You can also connect your MIDI controller to this to play an endless array of instruments.

4. PLAYLIST WINDOW
This is where you piece together all the elements of the song to create a finished track. It works in a similar way to the piano roll.

5. MIXER
All audio in FL Studio passes through the mixer, this is where you can alter the quality and levels of the audio signal.

track. This is where the layering of the patterns you create will be orchestrated.

» To listen to what this window sounds like, we need to head back up to the top and select the 'song' button instead of the 'pat' button next to the play and stop function. So now we will be taking what we have created and applying it to the playlist window, similar to how we created layers in the piano roll.

» Click in the track 1 row and draw out the pattern four times. Then to listen, hit the spacebar to hear this sequence. We were testing too, don't slate us for our purely experimental patterns. To help with organization and pattern naming, in the channel rack press the F2 key to rename a pattern. This will help you when things start to get messy.

» As we mentioned earlier, songs are made of layers. We have our drums (kind of) so to add a new layer, press the '+' icon next to where your pattern name is in the top window bar. This will create a blank new pattern and you will notice that the channel rack is now empty.

» Here we can add in a new 'sound', for example, a guitar riff or piano keys. This is where you will start to layer your song. You can also drag audio files straight from the browser to the playlist window to add them directly if no tweaking is needed.

ANOTHER MUSIC TUTORIAL NEXT MONTH

» The arrangement will be done in the playlist window, but the construction of the riffs and melodies is created in the channel rack and piano roll. Music production certainly isn't a quick and easy thing to do.

» The key is to have fun with what you are doing and to keep practicing over and over again—experimenting with layering different sounds together, mixing samples, and splicing instruments together until you have some form of song at the end.

» This guide might not help you become a successful music producer overnight, it's simply a basic overview of how the main sections of a DAW work, in this case, FL Studio 20. If you are serious about learning to compose digital music, you could do some research on music theory before diving right in to get an understanding of how songs are written. There are a plethora of videos and tutorials online about how to construct basic melodies and rhythms, and piece together all the elements to create a track.

» Once you get used to how these applications work, with some practice and a bit of patience, you should be able to compose a basic tune. ⏻

© FL STUDIO

LAB NOTES

JEREMY LAIRD, EDITOR

Gaming laptops suck

Tell me I'm wrong

GAMING LAPTOPS have always sucked in certain ways, such as limited upgradeability, lower performance than a desktop, and painful pricing. OK, a laptop is currently one of the few ways to get hold of a half-decent GPU at a sensible price. Forking out for a high-end laptop rather ruins crypto returns, so gaming laptop sales generally go to gamers who want to play games.

But when GPU pricing and availability eventually return to normality, gaming laptops will again be poor value in terms of pure performance. But it's not really those obvious issues that bug me. Over the years, I've run something like 10 powerful gaming laptops. It all started when I bought a Dell Inspiron 5000 with a Radeon 7500 Mobility chip circa 2002 or 2003. That 15-inch lump had a 1,600 by 1,200 panel. Playing *Counter-Strike* at native res was actually doable and looked epic. At least, it did back then.

As it happens, that was probably the high point of my laptop adventures. Since then, I've bankrolled another three myself. But one benefit of being in the tech media is long-term loans, taking the total to about 10. Without exception, all have been borked.

I won't name and shame on the basis that every gaming laptop has disappointed. Many impress with their ability to squeeze incredible rendering power into a portable package. That was true back when the Nvidia GeForce 6800 was a thing and the gap between desktop and laptop graphics performance shrank to almost nothing.

Granted, desktop performance tends to degrade a little over time. But every gaming laptop I've run long-term has felt seriously strained over time. Sometimes, it was a case of noisier fans. But often, visual artifacting would creep in or, worse, total system hangs.

Will XPG's Xenia be another disappointment?

I've taken some apart to no avail, implying the problem wasn't dirt but perhaps circuit or board strain. Of course, a portable rig takes more knocks. But my spidey sense tells me it's more the limitations of tight packaging and narrow thermal margins. It's a recipe for flakiness in the long run.

And in the short term, too. My outgoing portable rig with an RTX 2080 chip doesn't like outputting to an external display. Change the res and the refresh turns chunky until a full reboot. Not the end of the world, but the kind of niggle I find all too often in laptops. But maybe it's just me and you have a different take. If so, let rip and tell me I'm wrong.

SAM LEWIS

Staff writer

In the last issue, I was about to check out some new releases from *Call of Duty*, *Forza*, *Grand Theft Auto*, and *Battlefield*—quite a list of triple-A titles there. In theory, it should have been a joyous and exciting time, sinking hours into playing these games, but where to start? The *Call of Duty* general multiplayer isn't bad, but nor am I thrilled by it. For me, nothing will match the nostalgic highs of the original *Modern Warfare* games, *World at War*, or the first two *Black Ops* titles.

However, in *COD*, Vanguard has butchered Zombies by messing with the round-based mechanics that make it so timeless. This is coming back in updates, but it shouldn't have been an issue.

Forza Horizon 5 is great and hasn't given me anything, yet, to bash my brains about. It has kept to what works and has added a little to it. Another big disappointment lies in the *Grand Theft Auto: The Trilogy Definitive Edition* release. Oh boy, this is a shambles! What should have been a positive and exciting time for *GTA* fans turned into Rockstar being a laughing stock. An abundance of glitches has stopped these titles from being a great nostalgic trip for everyone.

As for *Battlefield 2042*, I haven't invested much time into this yet so we will have to see. Right now though, *Forza* will be the only game I continue to play unless some pretty big updates come our way for the other titles.

Editor's Pick: HDMI 2.1...

...ain't what it used to be

HOORAY for HDMI, the friendliest of display interfaces. Who needs anything else, especially now HDMI 2.1 supports both 4K@120Hz and 8K@60Hz? Well, you might if you want even faster refresh at 4K or daisy-chaining. And that might not be an entirely unrealistic expectation when AMD and Nvidia's next-gen GPUs arrive later in 2022. Rumors suggest an even bigger step forward in performance than last time around. 200Hz-plus gaming at 4K? Don't rule it out.

But I digress. There's no question HDMI 2.1 is a good thing for PC users. As well as supporting lots of pixels and high refresh rates, it's also adaptive-sync capable and includes support for low-latency display connections. This is enabling a new generation of HDTVs that play nicely with the PC—if you have an HDMI 2.1 graphics card. Which you won't, unless you have either an Nvidia GeForce RTX 30 series or an AMD Radeon RX 6000 series.

Still, as HDMI 2.1 graphics cards eventually become the norm, PC users will have the option of a wide range of HDMI TVs, which deliver more bang for your buck than PC monitors. Sure, many are too big for ergonomic PC use, but a new class of HDMI 2.1 4K monitors designed for the latest games consoles and marketed at a lower price than a comparable PC monitor courtesy of HDMI 2.1 is incoming, too. A 32-inch 4K@120Hz HDMI 2.1 monitor? Sign me up, please.

So, it's all gravy when it comes to HDMI 2.1, then? Not quite. So far, HDMI 2.1 has been associated most importantly with the ability to support 4K@120Hz with full 10-bit uncompressed color. That's courtesy of a maximum bandwidth of 48Gbps. Now, it's true that not all displays and indeed output devices with HDMI 2.1 support have thus far supported the full 48Gbps. At launch, the Sony PlayStation 5 was capped at 32Mbps and the Xbox Series X at 40Gbps. In the case of the PS5, that means color fidelity at 4K@120Hz has to be reduced.

Anyway, the point is that you have to be careful not to make too many assumptions about HDMI 2.1. The devil is in the detail. Sadly, that's just about to get a whole lot worse. It turns out, according to the HDMI Licensing Administrator, that HDMI 2.0 no longer exists. Its features are now a subset of HDMI 2.1. But here's the kicker. The HDMI Licensing Administrator says that "all the new capabilities and features associated with HDMI 2.1 are optional. This includes FRL, the higher bandwidths, VRR, ALLM, and everything else."

In other words, it is now possible to buy an HDMI 2.1 display that can't do 4K@120Hz, adaptive refresh, or auto low latency. HDMI 2.1 no longer guarantees any of that stuff. It's a bizarre decision that's not only guaranteed to confuse consumers but also encourage display makers to cynically recertify what were once HDMI 2.0 displays as HDMI 2.1 compliant. Because they will be.

Of course, these standards bodies have form. The USB Implementers Forum did unspeakable things when they folded USB 3.0 and 3.1 into USB 3.2, leaving the latter as a broad church with little meaning and supporting anything from 5Gbps to 20Gbps. Before we had USB 3.0, USB 3.1 and USB 3.2, now we have USB 3.2 Gen 1, USB 3.2 Gen 2 and USB 3.2 Gen 2x2. How anyone thinks this is progress defies belief. The same goes for the changes to HDMI 2.1 nomenclature. It's hard to see the benefit. Whatever, you have been warned. HDMI 2.1 ain't what it used to be. **–JL**

Reviewed...

74 Gigabyte RTX 3070 Ti Gaming OC

76 MSI GS76 Stealth
78 Asus ROG Zephyrus G14 Alan Walker Special Edition

80 Dell S2722DGM
82 HP Z43
85 Endgame Gear XM1 RGB White
87 EPOS Adapt 360 White
88 ASUS ROG STRIX Scope TKL Deluxe

89 ASUS ROG Ryujin II 360 AIO

90 Forza Horizon 5
92 FL Studio 20 vs. Pro Tools

Gigabyte RTX 3070 Ti Gaming OC

Factory overclocking only gets you so far

GIGABYTE'S RTX 3070 TI GAMING OC follows the typical path of custom AIB designs, rather than trying to blaze any new trails. You get a larger card, improved cooling, a slight factory overclock, and some other cosmetic differences. It's a conservative approach, though Nvidia doesn't allow for much more than that. Unfortunately, the biggest concerns with the RTX 3070 Ti remain; higher power use, minor performance gains, only 8GB of memory, and it's sold out and overpriced at most retailers. We've seen it all before and we will see it again in the next round of GPUs.

The Gigabyte overclock only improved performance by about two percent on average compared to the reference clocked Founders Edition, though that's not the only difference. Power use also increased by about 20W over the reference design, while GPU temperatures dropped 13C. The card wasn't really any quieter, but higher performance at lower temperatures proves the overall quality of the design. Alternatively, it proves that Nvidia's RTX 30-series Founders Edition designs aren't all that great.

Performance from the RTX 3070 Ti still ranks just ahead of AMD's competing RX 6800 but a bit behind the RX 6800 XT—unless you run a game with lots of ray-tracing effects like Control or Cyberpunk 2077, in which case the AMD cards tend to fall on their face. Turning on DLSS in quality mode just adds insult to injury, often improving performance by another 15 to 20 percent without a discernable loss in image quality. There are now over 140 games that support DLSS, and Nvidia's latest DLSS 2.3 further improves the algorithm to reduce the ghosting effect that was sometimes visible with previous versions. DLSS remains arguably the best feature of Nvidia graphics cards, and FSR doesn't really compare.

The lack of VRAM isn't just some hypothetical problem. In the past few months, we have seen multiple games launch that very much want you to have more than 8GB of memory at maximum quality. For example, *Battlefield 2042* and *Halo Infinite* can struggle at 1440p ultra with an 8GB card. There are plenty of other examples of games that exceed 8GB, and while it's possible to drop texture quality a notch to work around this, is that something you want to do on a graphics card nominally worth $600?

However, the biggest problem is something that continues to affect all graphics cards. Six months after it officially launched, the GeForce RTX 3070 Ti remains questionable value and one that's hard to find in stock, with most selling for extreme prices on eBay or similar sites. Your best chance to actually acquire any current generation GPU without paying a massive premium is to go out and buy a prebuilt PC, at which point, it's often luck of the draw as far as the particular model of graphics card you will be getting. It could be this Gigabyte, or it might be an Asus, EVGA, MSI, or some other brand.

The real conundrum at this point is whether to wait or not. It's coming up to 18 months since the RTX 3080 first arrived and Nvidia typically follows an 18-24 month cycle between new architectures. The continuing impact of the pandemic and the resulting global supply chain issues might delay the next-generation RTX 40-series until later this year, but if you can, waiting for better pricing and availability is the sensible approach.

Then again, there's always something new coming down the pipeline. Like thunder follows lightning and summer follows spring, there will be future next-generation GPUs after the RTX 40-series and Lovelace architecture launch. If you can find a Gigabyte RTX 3070 Ti card in stock at a decent price—and really, that goes for any current-generation RTX 30-series or RX 6000-series card—then go ahead and upgrade. Then do it again in another couple of years. That's the life of the enthusiast. **–JARRED WALTON**

VERDICT **7**

Gigabyte RTX 3070 Ti Gaming OC

+ DÉJÀ VU Good cooler; dual HDMI ports; proven design.

– DÉJÀ VU Minimal gains; high power use; not enough VRAM.

$1200, www.gigabyte.com

BENCHMARKS

	Gigabyte 3070 Ti	RTX 3070 Ti	RX 6800	RX 6700 XT
8 Game Average	**100 / 77**	98 / 75	95 / 73	82 / 60
Assassin's Creed Valhalla	100 / 83	97 / 80	**120 / 93**	105 / 79
Borderlands 3	131 / 96	125 / 92	**156 / 112**	128 / 88
Control (DXR)	**77 / 51**	76 / 49	53 / 34	46 / 28
Cyberpunk 2077 (DXR)	**52 / 34**	51 / 33	30 / 20	29 / 18
Dirt 5	137 / 106	133 / 106	**140 / 114**	115 / 92
Horizon Zero Dawn	124 / 114	124 / 112	**142 / 119**	121 / 97
Metro Exodus	**106 / 87**	104 / 83	102 / 85	89 / 71
Red Dead Redemption 2	105 / 88	106 / 88	**114 / 96**	93 / 77

Best scores are in bold. All testing conducted with a Core i9-9900K, MSI MEG Z390 ACE, 2x16GB DDR4-3600 CL16, 2TB XPG 8200 Pro M.2 SSD, Thermaltake Toughpower GF1 1000W. Scores are average framerates at 1920x1080/2560x1440, with ray tracing enabled in Control and Cyberpunk.

SPECIFICATIONS

Architecture	Ampere GA104
Lithography	Samsung 8N
Boost Clock	1830MHz
GPU Cores	6144
Memory	8GB GDDR6X
TFLOPS FP32	22.5
Bandwidth	608GBps
TDP	310W
Connectors	2x HDMI 2.1, 2x DisplayPort 1.4

This RTX 3070 Ti is cooler but only slightly better performing than the Founders Edition.

A mature, grown-up gaming laptop.

MSI GS76 Stealth

Potent power in a slick, stealthy chassis

LAPTOPS WERE DESIGNED as a portable and practical on-the-go alternative to your desktop computer. However, 17-inch laptops tend to fall somewhere between the two. As good as they are at providing you with the equivalent of desktop power or more, plus they often have better cooling solutions and specs than smaller alternatives, what they can't deliver is the same level of practicality. You can't sling one of these into a backpack, as they aren't the easiest nor the lightest devices to carry around. Yet, they offer something pretty cool and if you are unsure whether to get a desktop or a traditional laptop, they are an ideal compromise.

MSI is no stranger to 17-inch devices and the GS76 Stealth is certainly a looker, with some pretty hefty specs under the hood. Let's start with the design, which certainly lives up to the Stealth name. Compared with the MSI GE76 Raider, another 17-inch MSI laptop we tested recently, this is a more slick and premium-feeling device. Finished in full-core black metal, it's one of the best designs we have seen from MSI.

It's pretty subtle for such a large device and that gives it an illusion of being smaller than it actually is. It's also pretty slim for this configuration, coming in at 0.8-inches thick. At a glance, and with the RGB keyboard turned off, you'd struggle to know that this was a gaming-focused laptop—it seems like a more mature step up from its GE76 Raider sibling.

The screen fits the chassis nicely too, with the same thickness of bezel around the sides and the top, and fitting a 720p webcam along the top edge. It's nothing too fancy, but this cam does allow for Windows Hello login, which is handy and does the job for the occasional zoom call.

Back to the screen, this model features the 360Hz Full HD IPS panel. It's not the punchiest of displays, with pretty low contrast, but that 360Hz refresh rate means it is super-snappy. There is a QHD screen in the range, with a 240Hz refresh rate, but we would opt for the model we have on test here. More than likely, you'll be using this laptop quite close to the display and will benefit more from the extra Hz and smoother feel in games.

Below this, you get a fairly deep air vent which is great for cooling, however, it does take up rather a lot of space at the bottom that could have been better employed for a larger mouse pad. Below the air vents is the impressive keyboard from Steelseries, featuring per-key RGB lighting. The keys deliver deep travel without feeling too spongy and yet still provide a satisfying click. You can alter bindings and the RGB in the Steelseries GG application that's pre-installed too.

Below the keyboard, are the speakers. Fitted with a Dynaudio sound system, the GS76 Stealth delivers a deep and warm sound that is easily good and loud enough for media consumption. It's more than likely that you'll pair up a headset for gaming or playing videos, but it's nice to fall back on nonetheless.

Also underneath the lid is the mousepad, which is fairly narrow for a 17-inch laptop, but has a soft finish and is perfectly good enough for everyday use. The right-click is nice and responsive but on our sample, the left button had lost its click. Hopefully, it was just a problem for us, but it hindered our time with it. As for ports, the GS76 Stealth has plenty to offer with the power, ethernet, headphone jack, and two USB-Cs on the left. On the other side, there are ports for the HDMI, SD card reader, Thunderbolt 4, and USB-C.

Where this PC fires into life though is underneath the chassis. Intel's i7-11800H is the brain behind this beast and powering alongside it is an Nvidia Geforce RTX 3070 card. It is super powerful, which is backed up by the benchmarks. It breezes past the 60fps target with the sliders cranked up. It performed exceptionally well on the Crystal Disk scores, thanks to the PCIe Gen4 x4 NVMe M.2 SSD inside. Overall, it doesn't seem to struggle with anything we throw at it.

Thermals aren't too bad either, thanks to an array of cooling vents around the fan. If you are after flat-out power and a gaming aesthetic, MSI's chunkier, crazier sibling, the GE76 Raider, might be more up your street. However, if you want something that is still lightning fast but in a more premium package, then the MSI GS76 Stealth could be the one. **–SAM LEWIS**

BENCHMARKS

	ZERO-POINT	
CineBench R15 Multi (Index)	2,137	1,835 (-14%)
CrystalDisk Q32T1 Sequential Read (MB/s)	3,595	6,944 (93%)
CrystalDisk Q32T1 Sequential Write (MB/s)	3,107	5,249 (69%)
3DMark: Fire Strike (Index)	20,529	21,055 (3%)
Rise of the Tomb Raider (fps)	107	137 (28%)
Total War: Warhammer II (fps)	83	96 (16%)
Tom Clancy's Ghost Recon: Wildlands (fps)	61	93 (52%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our gaming laptop zero-point is the ASUS ROG Zephyrus G15, with an AMD Ryzen 9 5900HS, Nvidia GeForce RTX 3080 and 32GB of DDR4-3200. All game tests are performed at 1080p at the highest graphical profile.

VERDICT 9

MSI GS76 Stealth 11UG

+ **STEALTH BOMBER** Ultra fast performance; premium design, tactile Steelseries keyboard; speedy refresh rate.

− **LOCATION COMPROMISED** Poor battery; small trackpad; fingerprint magnet.

$3500 (est), www.msi.com

SPECIFICATIONS

CPU	Intel i7-11800H
Graphics	NVIDIA GeForce RTX 3070 GDDR6 8GB
RAM	32GB DDR4 3200MHz
Screen	17.3" 1080p @ 360 Hz
Storage	1TB NVME M.2 SSD
Ports	2x Type-A USB 3.2 Gen2, 1x Type-C USB 3.2 Gen2 (DP), 1x Type-C (Thunderbolt 4), 1x RJ45 Ethernet, 1x SD, 1x (8K @ 60Hz / 4K @ 120Hz) HDMI 2.1.
Connectivity	Killer WiFi 6E AX1675 (2x2), Bluetooth v5.2, Killer E3100 2.5GbE LAN
Weight	5.4lbs
Size	0.8 x 10.2 x 15.5-inches

Asus ROG Zephyrus G14 Alan Walker Special Edition

Gaming meets music in Asus's latest portable PC

GIVE IT UP FOR the new Asus ROG Zephyrus G14 Alan Walker Special Edition. It's a new version of the second iteration of what was already a great laptop. The original Asus ROG Zephyrus G14 was something of a genre buster when it arrived last year with its compact 14-inch proportions, awesome AMD CPU, and great gaming performance.

This second-generation Special Edition model carries over that basic proposition but adds an unusual twist, namely collaboration with the DJ and musician Alan Walker. As we write, Walker currently has the 19th most popular video on Youtube with no fewer than 3.2 billion views, not to mention over 10 billion channel views. Not bad.

Anyway, Walker has collaborated with Asus to produce a version of the G14 that fuses music with gaming. The basic design of the G14 is carried over, complete with the funky Anime Matrix programmable LED feature on the rear. But various tweaks, including a change to metallic grey, fabric inserts, and new keyboard colors give a distinct look.

What sets this version of the G14 apart from its siblings isn't the laptop but the extras in the box. Or rather the box itself. It doubles as a sort of synth or mixing pad, connecting to the laptop via USB-C and working with a dedicated app on the laptop to allow music content creation. Touch-sensitive pads on the box include controls for track speed, sample loading, and sound effects. These tie in with visual effects that can be run on the laptop's screen or output to an external display.

How well it works from a music content creation perspective is debatable, but it's a fun extra that adds to the sense of this being a special and unusual laptop, rather than a spec-led, box-ticking affair. That's probably just as well because at least in one area the spec is slightly disappointing. Highlights include the eight-core AMD Ryzen 9 5900HS CPU, which is incredibly powerful. The 14-inch 2,560 by 1,440 pixel IPS display is a 120Hz beauty and a great compromise between detail and performance, though it could be a little brighter.

At least it would strike that balance between pixels and frame rate nicely if it were paired with a more powerful GPU. Asus has gone with an Nvidia GeForce RTX 3050 Ti for this special edition G14, despite the chassis being good for up to the RTX 3060 in other models. That's a pity because the 3050 Ti isn't up to the job of driving the display at native resolution at playable frame rates, let alone the panel's 120Hz refresh.

Admittedly, games still look pretty decent interpolated at 1080p. So, while it is a realistic option to drop the resolution down a notch and release a few frames, an RTX 3060 would round the package out much more effectively and make for a better match for the high refresh display. Moreover, this isn't the kind of system that's aimed at price-sensitive buyers. The fact that you can have a 'regular' G14 with 32GB of RAM and an RTX 3060 GPU for around the same kind of money probably doesn't matter to this laptop's niche target market.

The extra cost of the 3060 would hardly make a major impact on its appeal. That said, this is still a gorgeous laptop with fantastic design and build quality, plus a battery life of over eight hours in PCMark 10, especially given the huge CPU power on offer. The sound from the integrated speakers rivals Apple's MacBook's for dynamic range and quality, and there's some real bass on offer, albeit not so much outright volume. A bit more punch would be appreciated. –**JEREMY LAIRD**

VERDICT

8

Asus ROG Zephyrus G14 Alan Walker Special Edition

+ HIT SINGLE Lush build quality; awesome CPU; fun music features.

− DUD B-SIDE Mediocre graphics performance; expensive for the overall specifications.

$1,999, www.asus.com

BENCHMARKS

	Asus ROG Zephyrus G14 Alan Walker Special Edition
3DMark Fire Strike	12,665
Cinebench R20 Multi-core (points)	4,962
GeekBench 5 (single-core)	1,386
GeekBench 5 (multi-core)	7,379
PCMark 10 (points)	6,497
PCMark 10 Battery Life (h:m)	8:24
Video playback Battery Life (h:m)	9:40
Total War: Three Kingdoms (1080p, Ultra fps)	43
Metro Exodus (1080p, Ultra fps)	40

SPECIFICATIONS

CPU	AMD Ryzen 9 5900HS (eight cores, 16 threads, 3GHz base, boost up to 4.6GHz)
Graphics	Nvidia GeForce RTX 3050 Ti 4GB
RAM	16GB DDR4
Screen	14-inch, IPS, 2,560x1,440, 120Hz
Storage	1TB Samsung M.2 SSD
Optical drive	N/A
Ports	HDMI, 2x USB-C, 2x USB-A
Connectivity	Wi-Fi 6 (802.11ax)+Bluetooth 5.1
Camera	None
Weight	3.75lbs
Dimensions	12.76 x 8.74 x 0.78-inches

ROG ZEPHYRUS

Pricey and with niche appeal, this special edition G14 is still pretty sweet.

Dell's new 27-incher makes 1440p high-refresh gaming affordable, but with few thrills.

Dell S2722DGM

An affordable 1440p gaming monitor

IN THEORY, the new Dell S2722DGM is pretty much the perfect affordable gaming monitor. It's fast, cheap, has plenty of pixels, decent panel spec, and doesn't bother with frills and features that add little to the gaming experience.

It's built around a 1440p 27-inch VA panel with decent specifications. VA tech tends to be cheaper than IPS and with that come pros and cons. The most obvious advantage is static contrast. Dell rates this monitor at 3,000:1, which is almost three times better than any IPS monitor. However, despite the strong contrast, this is a straight-up SDR display with no HDR support. We're fine with that, given most so-called HDR PC monitors are nothing of the sort. Brightness is pegged at 350nits, which is fine for an SDR display.

The other major differentiator between VA and IPS is speed, as VA tends to be slower. The S2722DGM's pixel response is rated at 2ms GtG and 1ms MPRT, just behind the 1ms and 0.5ms ratings of the best IPS panels. Dell provides figures for how response performance relates to the user-configurable overdrive settings in the OSD menu. The other metric for speed is refresh. The S2722DGM is good for 165Hz, which is plenty. Chasing even higher rates would bring the extra costs of securing a GPU capable of keeping up.

The S2722DGM's 1440p native resolution equates to 2,560x1,440 pixels. On a 27-inch screen, that's a reasonable pixel density without generating the debilitating GPU load that comes with 4K. As for the Dell S2722DGM's broader feature set, don't expect too many extras. USB-C connectivity doesn't feature, but the dual HDMI and single DisplayPort connections are fine, even if the HDMI ports top out at 144Hz rather than 165Hz.

The chassis and stand are plastic but robust, with tilt and height adjustment included. Arguably the only irrelevance is the panel's 1500R curvature. It doesn't detract from the gaming experience, but on a 27-inch screen, doesn't add much either. If that doesn't qualify as a caveat, there's little else that does when it comes to image quality. The Dell S2722DGM is a punchy and vibrant monitor considering it's a pure SDR panel. The strong inherent contrast helps, ensuring you aren't shortchanged when running games that support HDR, such as *Cyberpunk 2077*, in SDR mode.

So, the Dell S2722DGM does eye candy just fine. It's also quick enough to deliver where speed matters most. But we'd steer clear of MPRT overdrive mode, which hammers the panel's brightness and vibrancy. 'Extreme' mode, rated at 2ms, suffers from a whiff of overshoot, but it's only just visible in-game, while 'Super fast' resolves the overshoot but allows a little smearing of darker tones.

Meanwhile, the 165Hz refresh ensures lag is a non-issue and adaptive sync is catered for via AMD FreeSync Premium certification. Owners of Nvidia GPUs will need to run in basic G-Sync compatibility mode, which in practice is just fine.

All told, the Dell S2722DGM isn't as quick as the best IPS monitors, but nor is it a slouch. For similar money, you could go with a fast 1080p IPS panel, but we'd lean towards giving up a bit of speed for the added pixels and visual detail of this Dell. That's especially true if you factor general computing into the equation. 1440p on a 27-inch panel makes for adequate pixel density for mundane tasks like font rendering and desktop space. 1080p is pretty low rent. –**JEREMY LAIRD**

VERDICT

8

Dell S2722DGM

⊞ **SIGHT TO BEHOLD** Decent overall image quality; strong contrast; reasonably quick.

⊟ **SEEN IT ALL BEFORE** Few features and frills; no HDR support.

$329, www.dell.com

SPECIFICATIONS

Panel size	27-inch
Panel technology	VA
Native resolution	2,560 x 1,440
Aspect Ratio	16:9
Refresh rate	165Hz
Response time	1ms MPRT, 2ms GtG
HDR	No
Contrast	3,000:1
Color	99 percent sRGB
Brightness	350cd/m2
Video Inputs	DisplayPort 1.2 x1, HDMI 2.0 x2
Other	AMD FreeSync Premium

HP Z43

Productivity on a massive scale

HP'S PRO LINE of "Z" monitors is bigger than ever before. The HP Z43 clocks in at a hefty 43 inches, but its size isn't the only way it differs from other HP Z screens. It's also more purely productivity orientated than some of the other members of the Z family, thanks to lower color fidelity.

At the core of the Z43 is a 42.5-inch IPS panel with full 4K resolution and 60Hz refresh. We've seen plenty of superficially similar 43-inch class 4K monitors before. But they've tended to have the feel of a cheap TV rebadged as a monitor, maybe with DisplayPort added for more PC-centric connectivity. With that in mind, it's not surprising to find most of those displays run VA panels, which is what you'd expect in an affordable 4K TV.

Anyway, that's not the case here. The Z43 isn't a quick-and-dirty TV adaptation but is clearly a high-quality product. All of HP's Z screens have gorgeous, nicely engineered enclosures and stands, and the Z43 is no exception. That said, partly as a consequence of the large 43-inch format, the stand is a little more limited than the HP Z norm, only offering tilt and swivel adjustments. The addition of height wouldn't go amiss.

As for further features, all the relevant input options are covered and each supports the display's full 4K@60Hz capabilities. There's both DisplayPort and mini-DisplayPort, plus HDMI and USB Type-C with DisplayPort Alt mode. The latter also delivers up to 65W of power, allowing for single-cable connectivity to laptops. What's more, with two USB-A inputs on the rear panel, plus a USB-A and USB-C located on the side, you have full hub capability when driving this monitor via USB-C.

But what about image quality? Overall, the Z43's panel specs are pretty modest once you get past the huge size and 3,840x2,160 native resolution. Peak brightness is 350 nits and there's no HDR support—this is a pure SDR panel. Static contrast is pegged at 1,000:1, which is fine, but not at the cutting edge, even for an IPS panel, let alone VA.

Then there's 60Hz refresh and 8ms response, which might seem a little sluggish, but is actually fine for a productivity panel. Less impressive, especially for an IPS panel, is the mere 96 percent coverage of the default sRGB color space. All told, then, this is a slightly old-school IPS panel on paper. And that's how the Z43 looks when you fire it up.

It's a decent performer, to be sure. But it's not hugely vibrant and the colors don't especially pop. A little of the characteristic "glow" that older generation IPS panels tend to exhibit is also visible. HP does include five levels of pixel overdrive in the OSD, the top three of which suffer from some pretty obvious inverse ghosting. Below that, there's no obvious overshoot, but the response is relatively tame. But then this isn't a monitor pitched at gamers.

Speaking of the OSD, it's worth noting that the color space presets available are limited, so calibration is needed to set most gamuts. The limited sRGB coverage rating means you won't get extensive coverage of demanding gamuts such as AdobeRGB or DCI-P3.

In that sense, this isn't really a monitor for pro content creation. It's a big screen with great connectivity designed for maximizing productivity. And it does that well, with one exception. At this size, even 4K makes for big pixels and a poor density of 103dpi. If you want crisp and clean fonts and lots of image detail at close quarters, this isn't the panel for you. Nor is it a great choice from a value perspective. If you can live without the USB-C hub, you can have a 43-inch 4K monitor for less than half the money. **–JEREMY LAIRD**

VERDICT **8**

HP Z43

+ SIZE MATTERS Really nice build quality; great connectivity; fab productivity.

– OVERWEIGHT Mediocre panel quality; low pixel density; pricey.

$1,099, www.hp.com

SPECIFICATIONS

Panel size	43-inch
Panel technology	IPS
Native resolution	3,840 x 2,160
Aspect Ratio	16:9
Refresh rate	60Hz
Response time	8ms GtG
HDR	No
Contrast	1,000:1
Color	96 percent sRGB
Brightness	350cd/m2
Video Inputs	DisplayPort 1.2 x1, Mini_displayPort 1.2 x1, HDMI 2.0 x1, USB-C with DP alt x1

STOVEPIPE WELLS
GENERAL STORE
EMERGENCY PUMP SHUT OFF SWITCH INSIDE
OPEN

Unlike most 43-inch 4K monitors which are VA, the Z43 rocks IPS panel tech.

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Endgame Gear XM1 RGB White

A fresh, crisp look for the charming XM1 mouse

ENDGAME'S XM1 lineup of mice has long been a reliable peripheral to have beside your keyboard as you prepare yourself to head into battle. At the core of the XM1, there is a performance-focused mouse with few extra gimmicks. Of course, it features an almost obligatory splash of RGB, but not enough to distract you or compromise your focus when gaming.

It's clear that this mouse hasn't taken many design cues from the Death Star's command center and instead has opted for a more basic approach. While there is a huge catalog of games and software that take advantage of a mouse with customizable switches, and some mice have screens and others have almost as many features as your PC itself, the XM1 tones things down and takes a more simplistic route.

There is no revolutionary design here, but that works in the XM1's favor—after all, its purpose is to connect you with your PC. But nor is this a basic mouse that you can pick up for under $10 at your local computer store. The XM1 features a five-button layout typically found on most gaming mice, which is all you really need for most scenarios.

The XM1 comes in two color schemes, black or white, and we feel the white model that's on test here is the better looking of the two. The main structure of the mouse is white soft-touch plastic with black side buttons and a scroll wheel. There is a subtle amount of RGB incorporated in the scroll wheel, the Endgame logo, and around the bottom edge of the mouse. It's not revolutionary, but its universal design means that it should match most setups nicely.

The mouse is also super-lightweight, weighing in at just 2.88oz (82g), as is the braided black cable. This gives it the feel of a wireless mouse and makes it easy to glide and swipe across, perfect for highly competitive gameplay situations.

Helping your gameplay even further is the awesome sensor in this mouse—the Pixart PMW3389 sensor is one of the best around. By default, it features auto-smoothing and acceleration of over 1,900cpi, however, this can be altered using Endgame's software. It's a fairly light application but allows you to reprogram the buttons and, more importantly, turn off smoothing over 1,850cpi to reduce motion delay. The sensitivity of the mouse can be changed in increments of 50 between 50 and 1,600cpi, giving you a reasonable amount of control over how it feels. There are mice with better control, including sensitivity control in single increments, but the XM1 performs exactly how you would want it to. It has a great gliding motion, thanks to two low-friction wide feet, one at the front and one at the back.

The Kailh GM 4.0 switches are equally as nice. Both the two front clickers have a small actuation to ensure a more rapid click. That's a consistent factor of this mouse, its lightweight nature and fast switches could give it the characteristics of a budget mouse, but Endgame has constructed it in such a way that these elements aren't present. It feels durable and the clicks should last up to 60 million presses—that's a fair few rounds on *Call of Duty: World at War: Zombies.*

The side buttons are also satisfying and easy to press, again with a quick actuation, but deep enough travel. Unfortunately, the scroll wheel doesn't follow suit— the click is a little too shallow and there's not quite the same satisfying appeal. The actual scroll ability redeems itself though. Coated in a grippy rubber with deeper grooves, the XM1 provides plenty of grip, even in more intense games after a few hours of playing. It's also easy to scroll slowly due to the distinct increments in the wheel.

Overall, Endgame has produced a great device that focuses its attention on the main purpose of a mouse, which is its performance. The XM1 largely avoids the gimmicky nature of other products and connects you to the game with not much else getting in the way.

Its lightweight nature, easy gliding, durable cable, and the great sensor inside all help to create a well-rounded mouse. It is no head-turner and the software is basic, but if you are in the market for a solid mouse, the XM1 is a good place to start your search. –SAM LEWIS

VERDICT 8

Endgame Gear XM1 RGB White

⊞ **GIMMICKS OUT** Great sensor; lightweight body and cable; clean design.

⊟ **FEW FEATURES** No support for macro or on-the-fly CPI adjustment; limiting software.

$70, www.endgamegear.com

SPECIFICATIONS

Sensor	Pixart PMW3389 Optical
Max sensitivity	16,000cpi
Acceleration	50G
Polling Rate	250Hz, 500Hz, 1,000Hz (adjustable)
Weight	0.18lbs

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EPOS Adapt 360 White

Party at the front, business at the back

EPOS IS A DANISH AUDIO HOUSE that falls under the Sennheiser umbrella. The ethos of the brand is split up into two distinct sectors, one for gaming and one for enterprise. EPOS's Adapt 360 headset finds itself in the enterprise category, coming in at $270. It aims to deliver the best of both worlds, a headset that you can use at work or on calls, and yet you can still use on the commute home and for leisure purposes. Does this headset meet these targets and is it a worthwhile purchase to use daily for work?

On the face of it, the Adapt 360 certainly looks like it fits this market. There's no revolutionary design here, just a crisp and subtle look that doesn't stand out but looks worthy of the price. They fold into a compact size, but unfortunately not completely flat, and come with a nylon carry case for portability.

The whole headset is covered in a flat soft-touch plastic with hints of a greyish brown to contrast. This is on each side of the headband and makes up the earcups, which feel pretty comfortable. Made from a plush memory foam leatherette, they cushion your ears without too much direct pressure. They aren't the most comfortable, but for long usage, whether it's work or leisure, they do the job. To help with comfort, they are pretty light too and easy to carry around on the daily commute. With this lightweight nature comes unfortunate side effects. The build feels a little cheap in comparison with other headphones of the same price bracket. There is a little bit of creaking when swiveling, which hinders these cans a little.

However, they are packed with features to help bridge the gap between leisure and commercial usage. In the box, there is a 2.5mm to 3.5mm cable, Bluetooth USB dongle, USB-C charging cable, and the carrying case. Connectivity is pretty decent, there is multipoint connectivity also to two Bluetooth devices for seamless transitioning. It's handy for switching from your phone to your PC, we all know how Bluetooth can be fiddly when swapping from devices so this is a great plus for the Adapt 360. When using the Bluetooth dongle, the headset has a dedicated button for Microsoft Teams, pushing the enterprise element yet further. It also has active noise control, which works pretty well for blocking out all the hustle and bustle of commuting, office background chatter, and anything else in between.

Like many headsets, the controls are found on the right earcup. There, you'll find the connectivity button, a slider to control the play/pause and skip controls, the volume button, USB-C cable, 2.5mm port, and the power button. That's quite the handful and it can get awkward trying to figure out what you are pressing. It's a little cramped and would be better suited to have controls on both cans. Still, the battery life is pretty impressive, boasting 30 hours with ANC on and 46 hours without it. This is more than enough and if you forget to charge one day, you have that peace of mind that there should still be enough in the bank.

As for audio quality, the Adapt 360 delivers a clear soundstage. Its detail is precise while maintaining strong mids. The bass delivery isn't quite as powerful as we'd like when listening to bass-heavy music, but for the majority of day-to-day usage, the sound is clear. The headphones are certified for Microsoft Teams and feature two microphones, so the audio pick-up is brilliant and could easily be used in an office environment.

This headset is a solid all-rounder, one that works well for both commercial and leisure purposes. EPOS has done a great job at bridging the gap between the two. However, the quality doesn't quite match the price, with the use of cheaper materials than some rivals. It could also do with more bass response. –SAM LEWIS

VERDICT **8**

EPOS Adapt 360 White

➕ **BUSINESS FOCUSED** Good ANC; Multipoint Bluetooth connectivity; crisp audio performance; good battery life.

➖ **SLIGHTLY OFF THE MARK** Soft bass; cheap-feeling materials; fiddly controls.

$269.00, www.eposaudio.com

SPECIFICATIONS

Driver Type	32mm dynamic driver
Frequency Response	18Hz to 22,000Hz
Impedance	21ohms
Connectivity	Bluetooth 5.0, Bluetooth USB Dongle, 2.5mm to 3.5mm audio cable, USB C
Design Style	Closed back
Weight	0.52lbs

ASUS ROG STRIX Scope TKL Deluxe

Is TKL the perfect size for gamers?

ASUS'S TKL RANGE is a compact alternative to the traditional keyboard. With a TKL 'TenKeyLess' keyboard, those 10 keys on a standard board that you hardly ever use have been dropped and this comes with a few benefits. If you are tight on desk space, having a keyboard that's 20 percent smaller than a standard board will give you more room. That larger space for your mouse could be useful when gaming. ASUS has taken the original ROG STRIX Scope keyboard and applied the TKL format to it, so is this a perfect solution for a gaming setup?

Straight out the box, this is a nice-looking bit of kit. For a small peripheral, it has a decent weight to it, which is ideal for a keyboard. The last thing you want is for it to move around when you are typing and to help with this, five rubberized grip pads do a great job of securing the board to the desk. The design features an aluminum top plate with a brushed finish, making the keyboard look like a premium gaming device.

It also feels pretty premium, too—the board comes with a leatherette wrist-rest, which is always a welcome addition. Unfortunately, this doesn't share the same weighty characteristics as the board and feels quite lightweight. It's magnetic and has rubberized feet to prevent sliding. The support itself is comfortable but could do with being a little taller for our liking. The same could also be said for the board, which has extendable feet but we could do with it raising the keyboard to a steeper angle.

Lighting is controlled by the ASUS Armoury Crate application, it also has ASUS Aura Sync to match with other ASUS RGB products. The RGB is certainly nice and bright, with the light dispersing pretty evenly across the board through and underneath the keycaps. There is also an underglow on this board, however, it will be covered up if you choose to use the wrist-rest—unlike offerings from Razer, where the wrist-rest features RGB too.

A single USB-C to USB-A 2.0 connects this to your PC or laptop. It is detachable, which is great if you need a longer cable, want a completely custom board with specific cabling, or break the cable and have to replace it.

STEALTH WORKER

There's one more cool little feature. On the top right is the stealth key. One press of this will hide all your apps and mute your audio. This is perfect if someone bolts through your door and catches you playing *Minecraft* when you're supposed to be working from home. We also found it handy when buying presents for Christmas to keep pesky eyes from ruining surprises.

Now let's focus on the mechanics. This board features RGB MX Cherry Red switches and these already have a solid reputation amongst gamers. With a linear response, these switches feel super fast and a softer spring results in a faster actuation too. The travel is 4mm but with a 2mm actuation, which is suitable for a gaming keyboard. It gives off the mechanical feel that we all love, but with the precision to take it straight into battle. It's not too loud either, which is great for all-day usage.

The TKL format suits this keyboard well and makes a pretty solid gaming accomplice. With a superbly rigid design, MX Cherry switches, wrist-rest, evenly-lit RGB, and some nifty little tricks, it makes for a good overall package. Unfortunately, it's not all good news, the keycaps themselves are a little slippy and they feature ASUS's ROG typeface, which isn't to everyone's taste. Also, the keeper could do with having another level of adjustment to make it steeper.

Those issues aside, this keyboard will make a great solution for a gaming setup. It's compact enough to take with you on the go, even with a gaming laptop perhaps. Overall, this isn't a bad on-the-go setup at all. **–SAM LEWIS**

VERDICT
8

ASUS ROG STRIX Scope TKL Deluxe

+ **QUICKSCOPE** Great build quality; excellent switches; multimedia controls; stealth privacy mode.

− **HARDSCOPE** No USB passthrough; key font is divisive; keyboard angle could be a little steeper.

$140, www.asus.com

SPECIFICATIONS

Switch Type	Cherry MX RED RGB
Switch Durability	100 million+ presses
Design Style	TKL
Connection	USB-C
Wrist-rest	Magnetic leatherette wrist-rest
Weight	2.40lbs

ASUS ROG Ryujin II 360 AIO

A cooler too hot to handle

WHEN YOU THINK about creating a new build, you may naturally concentrate your efforts on the most interesting parts, such as the processor or graphics card. While these are two of the most important components for performance, it's no good running a zippy PC if it heats your case up like an oven. An AIO cooler is vital to keep everything running smoothly and temperatures as low as possible whilst maintaining those performance speeds.

The ROG Ryujin II 369 AIO is ASUS's flagship cooler designed to keep even the hottest performing machines running nice and cool. If you are tight on space, there is also a smaller 240mm version. It's an impressive component, but should it become a part of your rig?

Design-wise, this is a sweet-looking AIO cooler. Beginning with the star of the show, the CPU pump head features an LCD panel, but not just any old panel—this happens to be the largest LCD on any AIO cooler on the market. Though it could be seen as a little gimmicky, this is ASUS's flagship model so naturally, it features all the bells and whistles. So what can you use this panel for?

First, it can be used as a showpiece item to make your rig stand out. The screen is customizable with some pretty neat uploadable images and animations, though more practical uses include system monitoring. It is connected through ASUS's Armoury Crate application and can display temperatures, voltages, frequencies, or fan speeds. This is all pretty crucial information and it's handy to just glance over at your case and make sure everything is running smoothly.

The screen can also display similar data but from AIDA64. This AIO comes with a one-year subscription to the AIDA64 Extreme software, one of the best industry-leading programs for system information.

That's not quite it for the CPU pump, though. It has another nifty trick up its sleeve. Embedded in the pump housing behind the LCD screen is a hidden 60mm fan, ensuring there is more than enough airflow to the CPU socket. Besides this fan, ROG Ryujin II 360 comes with three Noctua Industrial PPC-2000 PWM radiator fans. These are top-tier fans costing around $30 a piece, so it's good to see that the flagship model from ASUS has these included.

FAN CULTURE

Also included in the box is a fan controller hub, which is a nice addition. This features four RGB ports and four fan ports. Unusually, they aren't split traditionally, with one side for RGB and the other for fans. Instead, one side has a fan port with three RGB ports, and the other side has three fan ports with one RGB port. We're nitpicking here, but we found it a little odd. Regardless, at least they included this controller in the box.

Finally, we have the radiator which, as the name implies, is a pretty large 360mm rad. If you are using this with a demanding system, this is a great size to keep things nice and regulated. Tested with our Intel i9-12900K CPU and an ASUS ROG Strix GeForce RTX 3080, it handled everything we threw at it with plenty of headroom for comfortable overclocking potential. It ran quietly in our large Corsair 7000D Airflow case, even under some stressful gaming conditions. We achieved temps of between 104°F and 122°F (40-50°C) which we were happy with considering the quiet fan noise.

The question of whether you should buy one depends if your case is large enough to fit this in comfortably and your rig requires as much cooling as possible. If you're rocking some of the latest Intel or AMD CPUs with a hefty GPU, this will make an awesome addition to your system to keep things under control.

On the other hand, it could be overkill for your PC. If you have a less demanding system that could be kept cool by a smaller AIO then as awesome as it is, we can't recommend spending over $300 on this cooler—unless you think it's worth adding to your setup for that gorgeous screen alone. Overall, it's a great AIO that can handle demanding competitive gameplay and productivity-based tasks with some pretty neat features thrown into the mix too. –**SAM LEWIS**

VERDICT
9

ASUS ROG Ryujin II 360 AIO

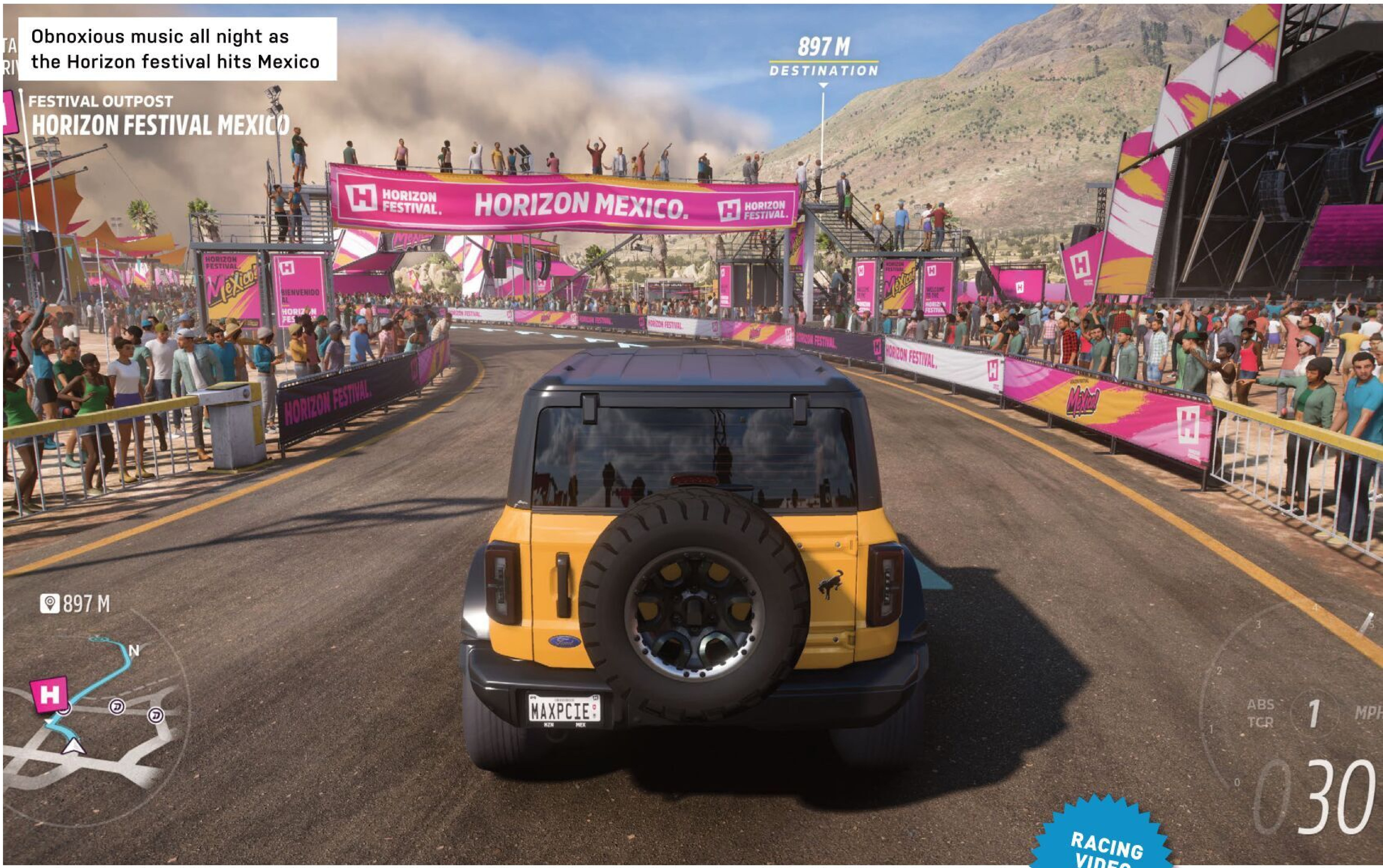
➕ **ICE COLD** Largest AIO LCD display; embedded 60mm CPU fan; Noctua fans.

➖ **IN HOT WATER** Bulky CPU block; pricey.

$310.00, www.asus.com

SPECIFICATIONS

Cooling type	Liquid Cooling System
Pump	7th gen Asetek pump
Radiator size	360mm
Fans	3x Noctua NF-F12 InductrialPPC 2000 PWM, 1x Pump embedded fan
Fan size	3x 120mm, 1x 60mm
Fan speed	450-2000rpm
Socket support	***Intel*** LGA 1150, 1151, 1152, 1155, 1156, 1200, 1366, 2011, 2011-3, 2066 ***AMD*** AM4, sTR4, sTRX4



Obnoxious music all night as the Horizon festival hits Mexico

RACING VIDEO GAME

Forza Horizon 5

Along the plains of Mexico

WERE THE HORIZON FESTIVAL real, we can imagine the bulk of its profits would be lost to lawsuits, its standing army of lawyers larger than the cadre of drivers it employs. This motor-racing circus turns up in your country—presumably invited in by someone in government not averse to acquiring large amounts of used notes in brown paper bags—and proceeds to make the lives of the residents absolute hell for the next year or so.

We saw this last incarnation when the festival rocked up in an oddly-shrunken version of Great Britain, smashed the place up, destroyed infrastructure that was hundreds of years old, ran old ladies off the road, ruined beauty spots unspoiled since the last ice age, played obnoxious music late into the night, then left again. This time it's Mexico's turn to have the dubious honor of hosting it.

It was Sega who first understood the importance of air power in rally games, and *Forza Horizon* seems determined to follow in those arcade footsteps. Dropping supercars out of the back of a cargo plane then immediately allowing you to race in them across desert and jungle is probably the most amazing piece of wish fulfillment yet committed to videogames, and it continues throughout. There's always something in the air, whether it's that plane again (the first race brings it back) or blimps, hot air balloons, drones.

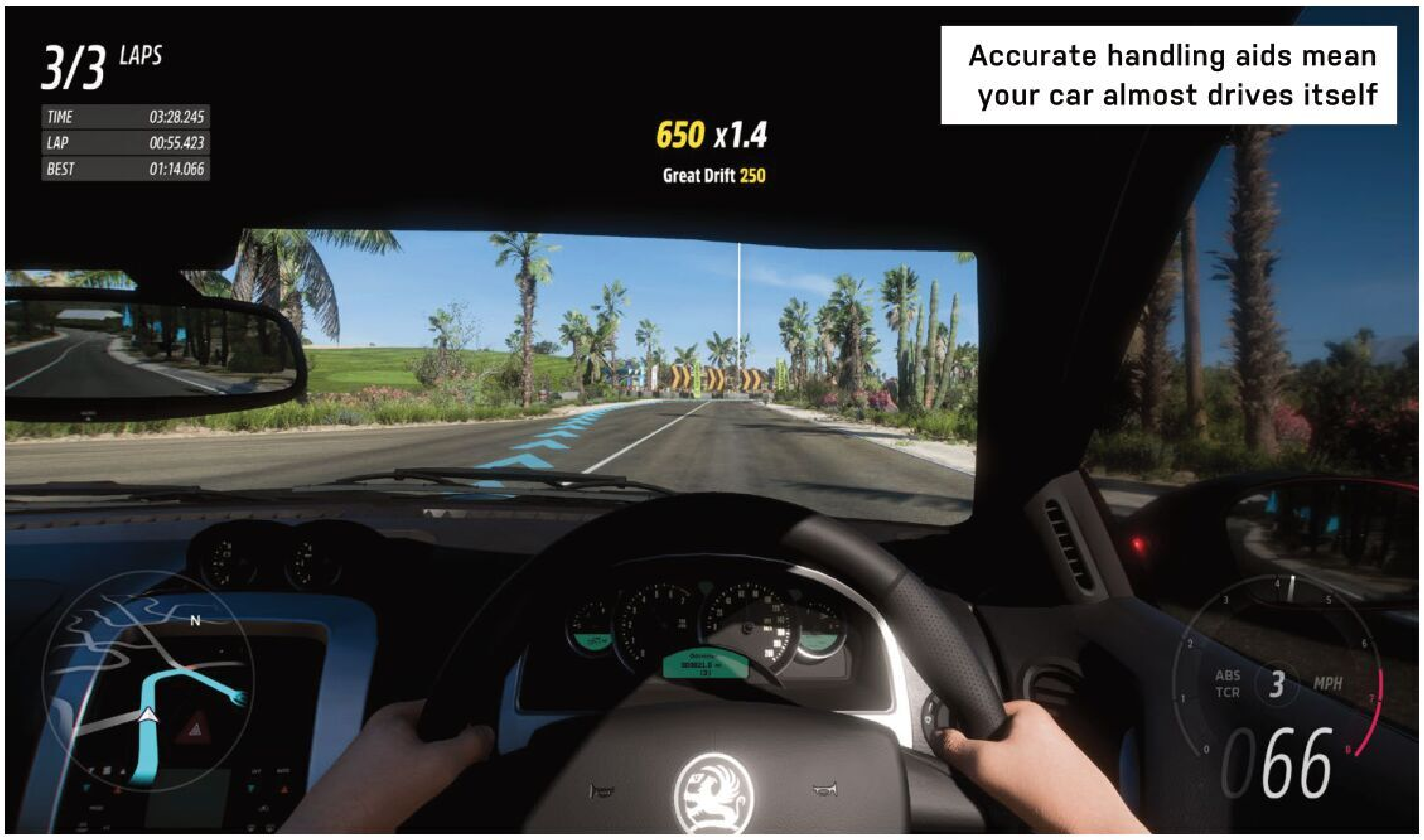
There's also a great deal of dust—the deserts of Mexico often throw up bright orange dust storms, and you're encouraged to drive into them in search of mysterious statues. There is some remarkable virtual tourism at work in these games, which take a compressed slice of their chosen country then expect you to explore it at speed.

You can always go back later, of course, to sit and marvel at a view, or pop up the photo mode (which insists on putting a watermark somewhere in your shot, presumably so your friends won't think you've taken a vacation south of the border and bought yourself an Aston Martin).

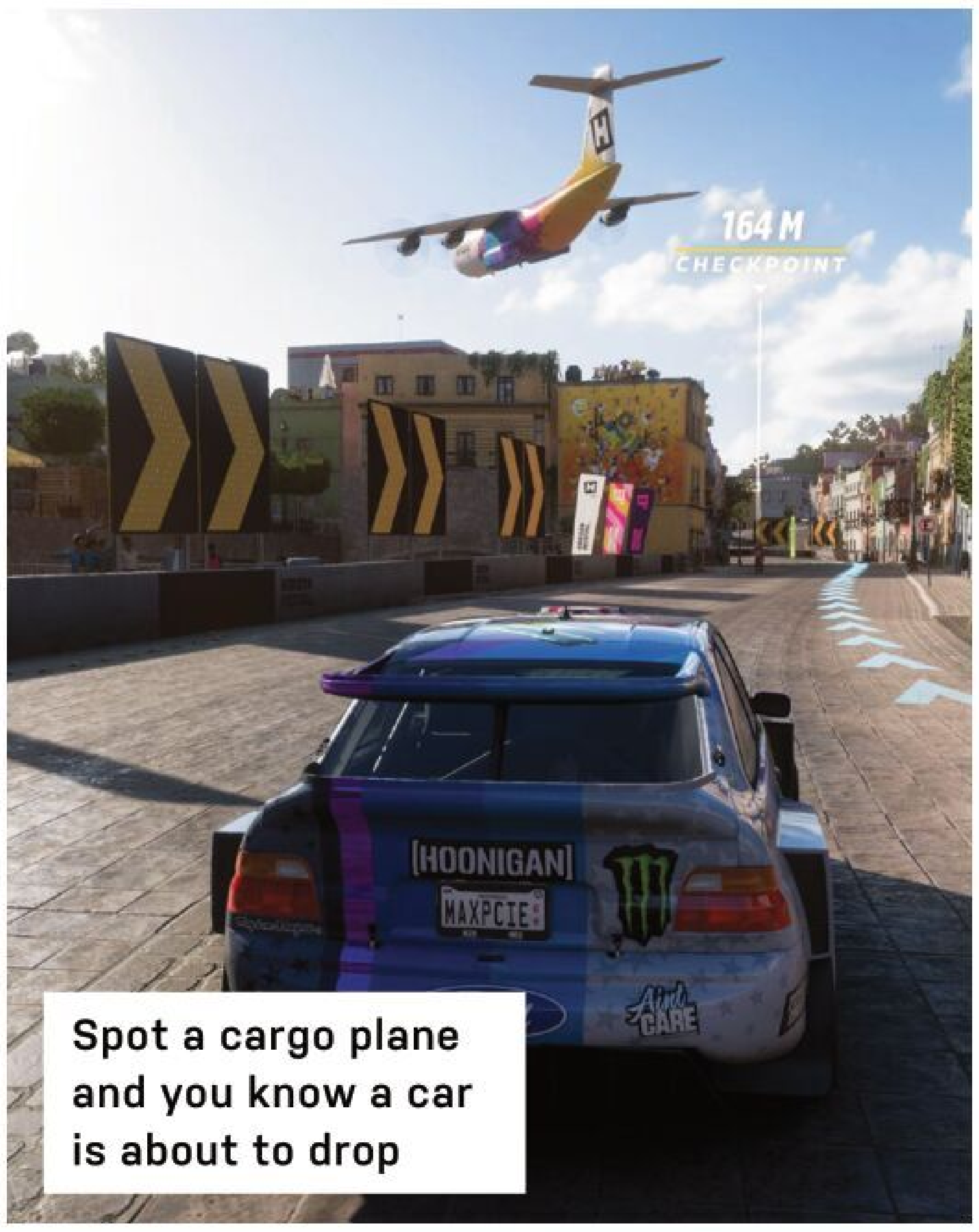
As a custom character introduced as the superstar attraction of the festival, which is hard to believe when you see them posing awkwardly next to a midrange hatchback they have just won a race in, you get some pretty nice toys to play with from the off. The character creator is fairly well-specced, allowing the usual purple-haired freaks and geeks to be designed, with the addition of prosthetic limbs and pronouns.

The game refers to you by the first name you've set in your account details (as long as it's on the list of voiced names) and all sorts of gender identities are represented. We're not sure if it was a bug, but our outwardly male-presenting character spoke with a female voice. The unflappable sat-nav remains a point of unintentional comic relief, as its deadpan delivery of 'please make a U-turn' is accompanied by clouds of brake smoke and the squeal of a highly-tuned piece of machinery being made to ride the edges of its performance envelope.

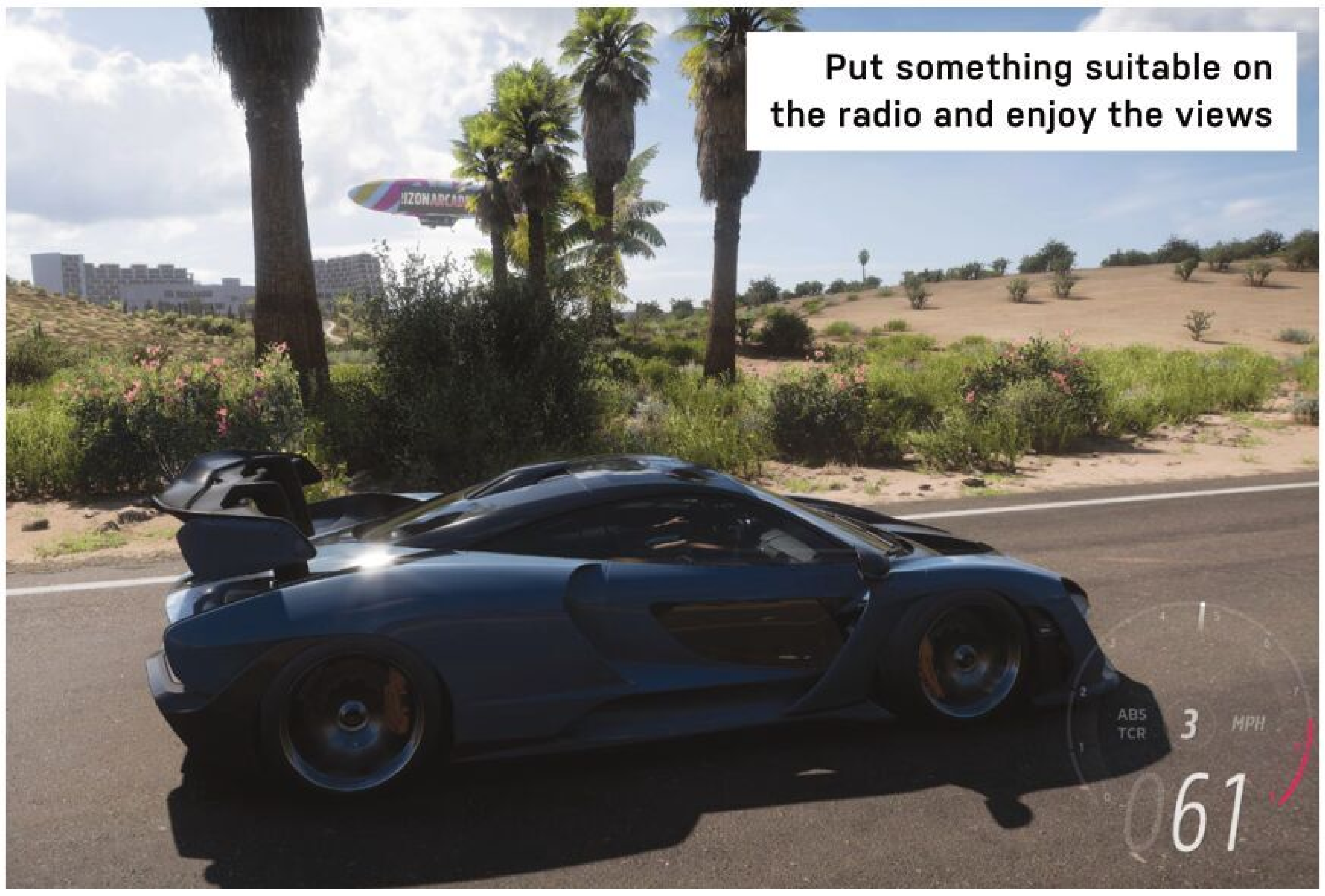
© XBOX GAME STUDIOS



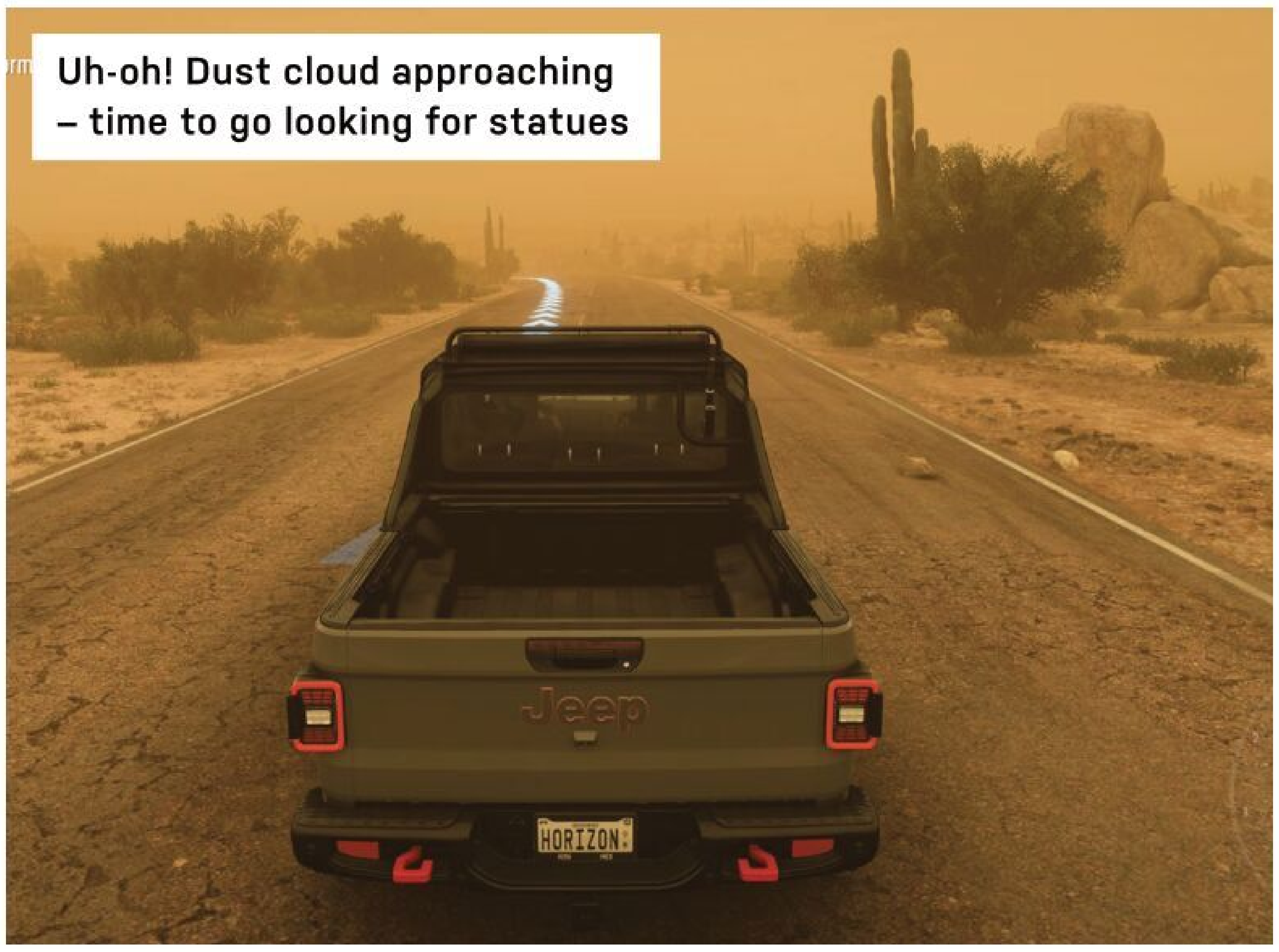
Accurate handling aids mean your car almost drives itself



Spot a cargo plane and you know a car is about to drop



Put something suitable on the radio and enjoy the views



Uh-oh! Dust cloud approaching – time to go looking for statues

© XBOX GAME STUDIOS

Having made a suitably bodacious entrance to the festivities, you're left with the map and the soothing voice of your assistant. Entering an event means driving there, and owning a car that fits its regulations, although the game will pit you against suitable opponents if you enter in something overpowered, which is much more likely than underpowered, even at the beginning of the game.

You can also tune your car so it fits the requirements for some events. Owners of *Horizon 4* get a few extra cars delivered to their garages, and it's fairly easy to pick up a couple more rides within the first few races—classic rally cars are just given away, apparently. Chasing after specific makes and models is all part of the game, and barn finds return, asking you to investigate out-of-the-way places in the hope of discovering something sleek and lovely under a sheet or some chickens.

Graphics in car games always look great, but in this open world, with its forests and dust storms, 3D spectators, and flocks of flamingos, the level of quality is kept so high throughout is a testament to both Playground Games' skill and the power of modern PCs.

NEW HORIZONS?

The game inherits the seasonal structure of previous games, changing conditions and events almost in real-time. However, not much is actually new. Aside from the Event Labs, a custom race creator that the community will need to get to grips with, this is the *Horizon 4* template stretched over a new country with different landscapes and festivals to experience. That's not a bad thing: with the tweaks and streamlining the game has received, it's now extremely good at being a *Forza Horizon* game.

Levels of handling accuracy mean you can play it in a car that practically drives itself, which feels appropriate for the laid-back nature of the game, or as something you and your expensive steering wheel setup need to wrestle with.

Likewise, the AI, which comprises a mix of anonymous racers and your friends' Drivatars, puts up as much of a challenge as you want it to. Add to that the licensed soundtrack, the sunny days, bright colors, and silly (but varied) driving challenges, and this is a celebration of the computer-powered car collection as much as it is a racing game.

You'll probably want to turn the damage off (it's fairly limited anyway) and just roll around with something suitable on the radio, enjoying this excellent world and everything it has in it. **–IAN EVENDEN**

VERDICT
9

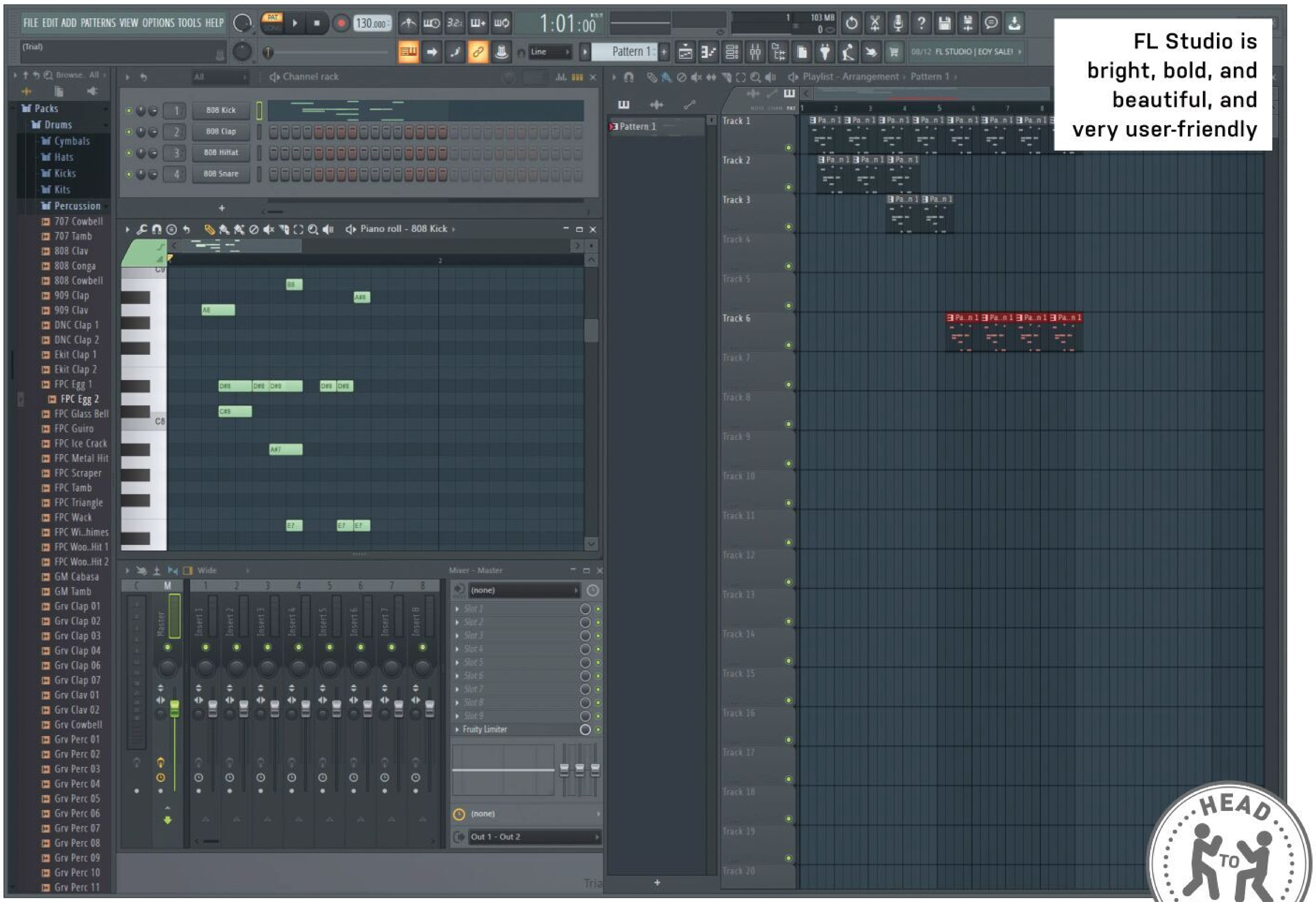
Forza Horizon 5

+ HORIZON Great looking open world racing and car collecting.

– COMPROMISIN' A few audio bugs; multiplayer can be hard to access.

RECOMMENDED SPECS CPU, i5-8500 / R5 1600X. RAM,: 16GB. GPU, GTX 1070 / RX 590.

$60, www.forzamotorsport.net, Rated E



FL Studio is bright, bold, and beautiful, and very user-friendly

© WWW.IMAGE-LINE.COM

FL Studio 20 vs Pro Tools

Which DAW hits the right notes?

WITH CREATIVITY-BASED software, many of the most popular and market-leading programs have several alternatives that carry out the same tasks, whether that's graphic design, photo-editing, or music production. There may be lots of reasons to pick one over the other, including price, features, or accessibility but familiarity with the program, suite, or company you are currently using may be a powerful reason to stick with what you know.

While alternatives may offer a similar or superior product, that decision often comes down to what you feel most comfortable using. This applies to digital audio workstations (DAWs) too. A DAW allows you to compile a variety of different sounds, samples, and instruments together to complete a polished final track.

Both Image-Line's FL Studio 20 and Avid's Pro Tools are capable programs that deliver high-quality professional-grade audio, so which one should you pick if you are starting out? And, if you already use one, is it worth switching over to the other?

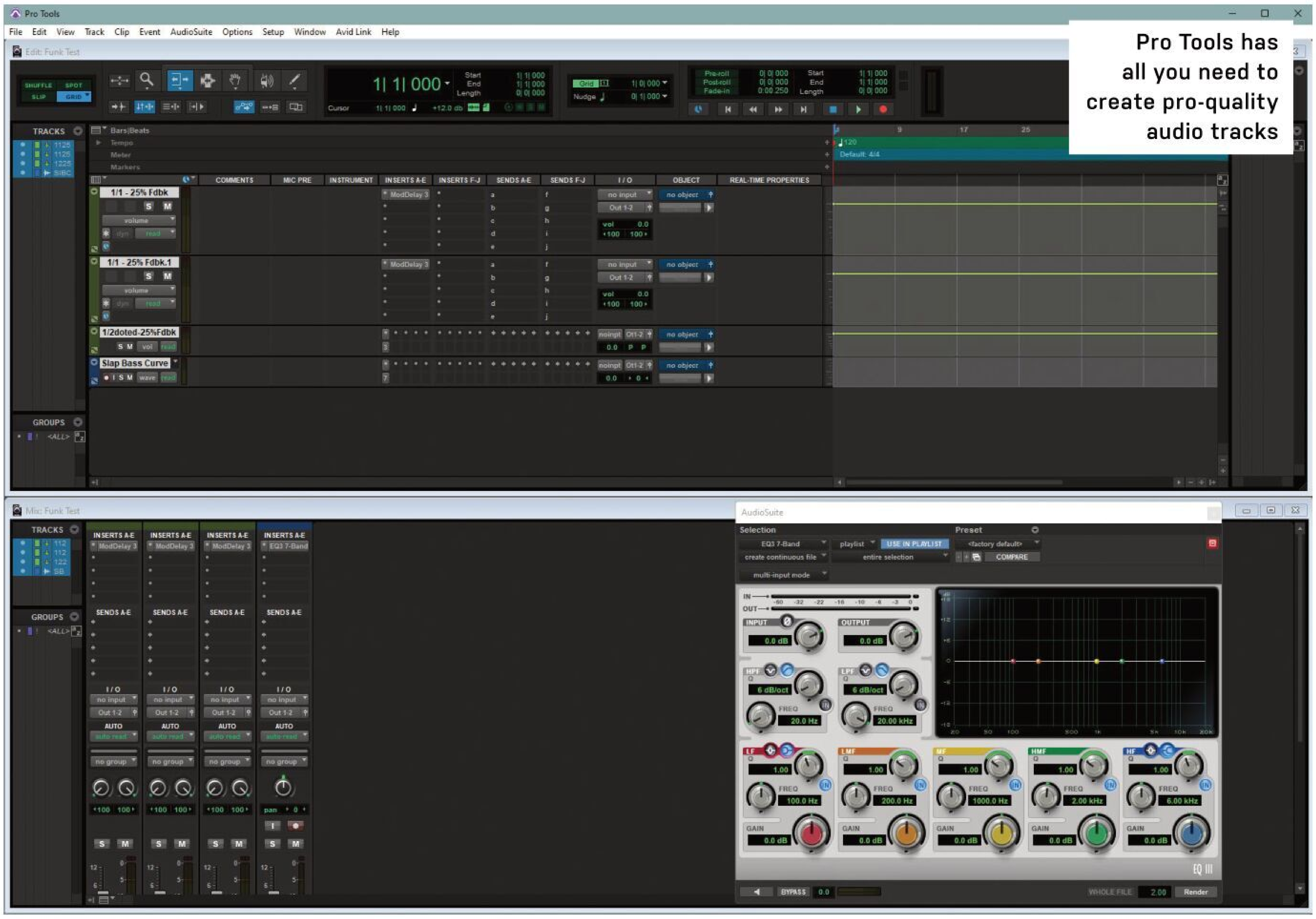
Avid's Pro Tools is considered the industry standard in digital audio workstations. Originally created by Digidesign, this piece of software has been through many variations and changes since it was first officially released under the Pro Tools name in 1991. Its popularity in the production industry has grown since then, and it has now become an essential tool for recording and mixing engineers.

Formerly known as FruityLoops, FL Studio began life at the end of the 1990s. This program was seen as a more introductory piece of software but, over time, it has become a professional-grade application with the potential to produce commercial audio. It was never initially intended for professional musicians, as the developers of the original Image-line software had no previous musical experience, instead their focus was on game design.

However, this different perspective is what made, and still makes, FL Studio so appealing—especially in terms of user interface design. The design language is vibrant, intuitive, and colorful. Its ease of use and 'friendly' styling harks back to the fact that Image-line came from a gaming background. At a time where most music applications looked as exciting as an Excel spreadsheet, FL Studio appealed to beginners. Although Pro Tools now has a clever UI, it still has a more corporate design that can be a little overwhelming. FL Studio's software feels more polished and user-friendly with its distinctive orange color scheme. Subtle design elements make the application an easier place to work. Both are pretty well organized DAWs, but Pro Tools' UI is a little sharper in some areas.

One main difference between these two DAWs is the price. FL Studio has four versions. The basic Fruity Edition costs $99 and comes with no audio clips or audio recording. Next up is the Producer Edition costing $199, which features audio recording, full playlist features, and six additional native plugins. The Signature Bundle costs $399 and comes with the same features, but has 13 additional native plugins instead of six.

At the top of the range is FL Studio All Plugins Addition, which has all of the native plugins for $499. This program certainly gets pricier the further you go up the range—factor in the additional packs, presets, samples, and loops, and you can end up spending a fair amount.



Pro Tools has all you need to create pro-quality audio tracks

Avid's Pro Tools works on a subscription basis. There are two versions available, Pro Tools and Pro Tools Ultimate. The regular version is $300 upfront or $30 a month for a one-year subscription, and $35 per month for a rolling monthly subscription. The Ultimate Edition comes with 192 (with HDX) channels of I/O compared to the regular 64. You also get 2048 audio tracks instead of 256, and the addition of surround and immersive multi-channel mixing, instead of just mono and stereo.

The Ultimate edition costs $800 per year, $80 monthly on a yearly subscription, or $90 on a rolling monthly basis. That works out pretty expensive, but both versions boast over $1,600 worth of free plugins, sound libraries, and training content though, which is a great addition.

In our view, FL Studio wins this battle based on its value for money—but it also has a neat trick up its sleeve. Purchase FL Studio and you get free updates for life, so you'll always have the latest version. In some respects, you get what you pay for, Pro Tools is a more well-rounded product that sets the bar for others, including FL Studio. Industry-standard doesn't have to be the best priced or best designed, there is a reason why it is being used by many recording studios. FL Studio's popularity comes down to its design and quality features in a fun package. It's not just for beginners, there are plenty of producers using it, hence the multiple versions.

Although these DAWs can both create the same outcome, the main difference is the target market. Pro Tools is focused on a more commercial high-end studio production market, whereas FL Studio's ease of use appeals to a younger audience who are getting into the audio production world. That's not to undermine FL, as it's an amazing piece of software that in most cases will be all you'll need, but with its intuitive, colorful, and bold aesthetic, beginners can get to grips with the foundations of audio production in a seamless manner.

If you want to try and practice audio production, but are unsure of how it will progress, FL Studio is a great place to start. For a slightly more professional and commercial route, practice with Pro Tools. For overall performance with a higher level of control and quality, Pro Tools is the DAW for you and will provide you with everything you'll ever need.

But for its great UI with lots of features, an intuitive style, FL Studio is a great place to start. In this battle of the DAWs, it has to be a tie—both offer great features at different price levels and are exceptionally good DAWs. It just depends on what level of production you are after. Both offer trials, so it's worth giving both a try-out to see which suits your needs. **–SAM LEWIS**

VERDICT 9

FL Studio 20

+ FRUITY Free lifetime updates; user-friendly; great piano roll.

– LOOPY Most powerful plugins only available in 'All Plugins Bundle'; tricky recording process.

OPERATING SYSTEM Windows 8.1, 10, 11 or later. CPU, Intel and AMD (ARM not supported), the more powerful the CPU the more instruments you can run. RAM, 4GB. Disk Space, 4GB.

FL Studio Fruity Edition $99
FL Studio Producer Edition $199
FL Studio Signature Bundle $299
FL Studio All Plugins Edition $499
www.image-line.com

VERDICT 9

Pro Tools

+ PRO TOOL Industry-leading standard; plenty of features.

– POOR TOOL Wallet-burning subscription costs; no upfront purchase option; design looks rather outdated.

OPERATING SYSTEM Windows 10, (Windows 11 not yet supported). CPU for Pro Tools—Intel Core i5 processor. CPU for Pro Tools Ultimate—Intel Core i9 or Intel Xeon processor. RAM, 16GB (32GB recommended). Disk Space, 15GB (installation)

Pro Tools one-year subscription $399
Pro Tools Ultimate one-year subscription $800
www.avid.com

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LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Audio-visual feast
> Jim and Sally build PCs
> The Ian Evenden Show
> Get networking

One for audio files...

I am a long-time subscriber and reader of *Maximum PC*. I would like a multimedia or home theater PC to connect to my home AV system, so that I can play audio and video (both audio/video files and from a streaming service), plus do some other PC stuff like browsing. The video playing and streaming need to be good but not high-end.

However, the audio playing (and streaming) needs to be as good a quality as possible, so the build needs to focus on this. The minimum quality of the audio files is lossless CD 16-bit/44.1kHz; FLAC format. I'll also play 24-bit/96kHz hi-res audio files.

My current AV receiver is a Pioneer Elite SC-68. I plan to upgrade this to a NAD M33, or something similar. Everything will be stereo. Even though the Pioneer can do surround sound it is being used as a stereo receiver. The main devices connected to the receiver will be the PC, a PVR, and maybe a couple of other devices. The video connection should be HDMI. The audio connection from the PC to the Pioneer/NAD/other needs to be the highest quality possible.

I have read about high-end devices such as Baetis Audio Prodigy X3, Exasound Delta, and Aurender N10. They are no doubt excellent, but being audiophile devices, they are overpriced, as they are essentially modified PCs.

The form factor needs to be smallish, something like the Intel NUC or Gigabyte Brix, or a CD player-like case. I will play most audio files from the SSD and the network connection will be hard-wired ethernet. I'm not sure what special components are required such as a better power supply, better audio outputs. **–John**

MAXIMUM PC EDITOR, JEREMY LAIRD RESPONDS: Okey doke, this is a nice problem to have. We love a good media rig around here. The good news is that fairly generic PC hardware can cope with relatively high-end video streams these days. We like the Intel NUC and Gigabyte Brix idea. This job does not call for a big, ugly box. One thing to bear in mind is that although modern CPUs have hardware video decode engines, just occasionally it might be handy to fall back to brute-forcing the video decode on the CPU.

For that reason, we'd recommend not skimping too much on the CPU. If you can stretch to six or more full-fat Intel or AMD cores, that would be just dandy. Of course, if your budget is tight, paying a premium for the small form factor probably isn't worth it. As it happens, we're expecting to take a look at what $500 buys you in terms of rig builds next month. Keep your scanners peeled for that if you want to avoid dishing out too many dollars.

That aside, also make sure whatever you buy supports at least HDMI 2.0 to enable 4K at 60Hz.

The audio half of the equation is a bit of a minefield. But here's a thought. What about an external DAC or digital to analog converter? Something like, say, the iFi Zen DAC V2. It's an external box that connects to your PC via USB and decodes digital audio, converts it to analog, and outputs a quality signal.

It has not only dual balanced 4.4mm jacks and a 6.3mm jack but also RCA connectivity and can operate as a digital preamp. It's currently yours for about $189, is both USB and mains powered, and gets strong reviews for its tonally even-handed sound. And, of course, it doesn't tie you into a particular PC or form factor. There are plenty of other DACs to choose from to suit almost any budget.

It's rig building, Jim, but not as our reader knows it

Once again, the NEW editor at M[*redacted!*] PC does an AMD vs Intel head-to-

↘ submit your questions to: editor@maximumpc.com head comparison. And, as usual, it's a comparison of a cherry to an apple, or even a watermelon to a grape. That's what I took away from the article in the December issue. It is really a comparison of who thinks they can build a better system for $1000.

Just like all past editors, you did the "Jim, here's $1000, go buy the best Intel system you can" and "Sally, here's $1000, go buy the best AMD system you can" article. Again, there is no way to do a fair comparison of the two systems. One has a six-core, 12 thread CPU. The other has eight cores and 16 threads. One has a Gen 3 PCI interface, the other 4th gen. Being the editor of stupidity, you actually thought this was an even comparison?

For a true head-to-head, you can only do it one way. You have one writer research the CPUs. Cost doesn't count. The number of cores and threads is the first item, then CPU speed. If one is at 3.9GHz, a fair comparison would be the other at 3.7GHz to 4.1GHz, a three to five percent difference, which is close enough. Also, disable turbo mode on the motherboard.

Next, the motherboard. Since most manufacturers make both AMD and Intel boards, you use one manufacturer. Again, cost is not the issue, we are looking at the features. They both should have as close to the same features as possible. Both have to be either Gen 3 or Gen 4 PCIe.

Now, to really make it a fair comparison, you get one drive, one set of memory, one case, one PSU, one PCU cooler [*Snip! We get the idea—Ed*].

–Name withheld

MAXIMUM PC EDITOR, JEREMY LAIRD RESPONDS: After admiring your enthusiasm, the first thing we'd do is suggest you think about something you just said. "Just like all past editors," you point out. Maybe, just maybe, it's always been done this way for a reason? In reality, few people specify a PC regardless of cost. So, when comparing the AMD and Intel options, the question comes down to, what can you get for your budget? And to answer that, well, cost counts. It really, really does.

Inevitably, it all gets rather complicated in the context of a fully built rig for a certain budget. There are so many variables and options, many of which are as much about preference as an objective advantage. But, broadly, the comparison holds and the question remains. What kind of results do you get for roughly the same money from each of the Intel and AMD platforms.

That's not to say your way of doing it doesn't have merit. Evening out the core counts and clocks, for instance, is absolutely necessary to get a detailed grip on how two different CPU architectures compare. But, the reality is that, at any given price point, AMD and Intel's CPU aren't going to be a perfect match in those areas. In fact, they hardly ever will be, given Intel's chip tend to clock higher.

Somewhat ironically, it's the insights of your preferred method that actually underline the fact that keeping cores and clocks closely matched while ignoring cost makes no sense. Prior to Alder Lake, AMD's latest cores did more work per cycle than Intel's. So, a clockspeed deficit for AMD doesn't translate into a performance win for Intel. Ultimately, it doesn't matter how AMD and Intel compare in a normalized contest. It matters how the AMD and Intel options you might actually buy stack up next to each other. Your way helps us understand why the options perform the way they do, but it doesn't help with what to actually buy.

Ultimately, this isn't about right and wrong, it's about what you want to learn. If you want to know what you'll get from Intel or AMD for a given budget, then you absolutely have to build to that budget, or at least very nearly. On the other hand, if you want to get a better idea of how the platforms and architectures compare in technical terms, normalizing a range of factors as you prescribe is the way to go. It's horses for, you guessed it, courses. Or to put it another way, your beef isn't with how we did it. It's just you want answers to a different set of questions.

The Ian Evenden show

I just wanted to give you some really positive feedback on the last few editions of *Maximum PC*. The expansion of coverage into adjacent areas, including articles on solar flares, quantum computing, and supercomputers, has been really welcome.

I thoroughly enjoyed all of them, and look forward to seeing more of this sort of thing. I know you will still stay true to your core subject matter, but these extra articles add a tremendous amount of value as a reader. Many thanks, and keep it up!

–Martin Evans

I just wanted to echo reader R.Linder's comments in the December issue on writer Ian Evenden's articles. As soon as I read that letter, I checked out to see who wrote the article on quantum computers, and I was right—it was Ian. Even though a lot of the article was above my head, it was intensely interesting, and I too was compelled to read it through to the end. I look forward to the future articles you mentioned he would be writing, as well as articles on software by others. Another interest of mine is computer system software tweaks. Thanks for a great magazine.

–David Thiel

MAXIMUM PC EDITOR, JEREMY LAIRD RESPONDS: Well said, Martin and David. Rest assured as these very words are typed on a ludicrously over specified 10-core rig, ably accompanied by a stupendously expensive GPU and used for little more than gawping at the web and banging out text—as is traditional among serious PC hardware geeks—Ian is working on further flights of tangential technological fancy. As they say, watch this space.

Getting to work on networking

I've noticed a couple of *Maximum PC* articles lately that had to do with networking, more or less, which has prompted me to write. I'm still running an AC router from 2014 that's overdue for an upgrade, and I've been tossing around the idea of a DIY one running something like pfSense. I've read a couple of online tutorials on doing it, but think it might be something you could do a deep dive on. Best box to build, best software to use and how to configure it for different uses, how to add Wi-Fi to the box if possible. Just a thought!

–Spencer Pearson

MAXIMUM PC EDITOR, JEREMY LAIRD RESPONDS: Thanks for your ideas, Spencer. It's maybe not quite what you're after, but while we ponder the pros and cons of covering pfSense, you might want to check out Nick Peers' guide to networking security in the January issue of *Maximum PC*

THE BUILDS

THIS MONTH'S STREET PRICES...

LAST MONTH, we gave the Intel budget build a slight upgrade from Core i3-10100 to Core i3-10105 with Intel's UHD Graphics 630. This month, we're going a step further by ditching the 10105 for the Core i5-10400. It's a six-core chip, so a 50 percent uptick in the core count for just $25 is a no-brainer. We're not sure how much longer 10th-Gen chips such as the 10400 will be available. So, if you fancy some cheap Intel six-core action, don't hesitate—the 10400 may not stay this affordable for long, and it could disappear altogether this year.

To recap from last issue, there were three parts that found their way into both the Intel and AMD budget systems. Due to a stock change last month, we had to change our memory around on the AMD budget build and the Intel budget build. We swapped out the Crucial Ballistix CL16 for GSkills Trident Z Neo CL 16 RAM. This is the same spec as the Crucial Ballistix RAM, so was the most suitable we could find at the price.

The next change was to the PSU's. For the Intel build, it was previously the 500W Aresgame AGV500 at an 80+ Bronze efficiency. On team AMD, the 500W Evga BA was the choice, also with an 80+ Bronze efficiency rating. These were both swapped around for a slightly more powerful 550W Corsair CV550 unit that has the same 80+ Bronze rating. Both builds also got an upgrade in HDDs from 1TB to 2TB for an increase of $8. With a sale on Newegg bringing these down from $70 to $47, it was impossible to not make the change. SSDs remained the same as they still perform strongly in the rigs and the prices haven't differed which is always good to see.

The last major change for these machines is the availability of GPUs. It is hard to recommend graphics cards that cost nearly double the MSRP, but they are there for anyone who doesn't want to wait any longer for more stock to come out. It's annoying for everyone else that this is the case, but at least there seems to be some street price stock and that's better than no stock at all.

AMD INGREDIENTS

PART		PRICE	STREET PRICE
Case	Corsair 4000D Airflow	$80	
PSU	5550W Corsair CV550 80+ Bronze	$40	
Mobo	ASRock B550 Phantom Gaming 4/ac AM4	$100	
CPU	AMD Ryzen 5 3600	$280	
GPU	MSI Radeon RX 6700 XT 12 GB MECH 2X **NEW**	$480	$890
RAM	16GB (2x8GB) G.Skill Trident Z Neo CL 16 @ 3600MHz	$90	
SSD	512GB XPG GAMMIX S50 Lite PCIe 4.0 M.2 SSD	$70	
HDD	2TB WD Blue 7200 HDD	$47	
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32	

Approximate Price: $1,219or $1,629

INTEL INGREDIENTS

PART		PRICE	STREET PRICE
Case	Corsair 4000D Airflow	$80	
PSU	5550W Corsair CV550 80+ Bronze	$40	
Mobo	MSI B460M-A PRO Micro ATX LGA1200 **NEW**	$104	
CPU	Intel Core i3-10400 **NEW**	$155	
GPU	MSI Ventus GeForce RTX 3060 12GB	$490	$884
RAM	16GB (2x8GB) G.Skill Trident Z Neo CL 16 @ 3600MHz	$90	
SSD	500GB Samsung 980 NVME M.2 PCIe 3.0 SSD	$60	
HDD	2TB WD Blue 7200 HDD	$47	
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32	

Approximate Price: $1,098 or $1,492

MID-RANGE

WE MADE SOME BIG CHANGES to the mid-range builds last time, so this month, it's minor tweaks. Inevitably, any reasonably priced GPU sells out, so both our builds have been revised. The AMD rig gets a Gigabyte GeForce RTX 3070 8 GB GAMING OC board that maintains the performance for slightly more cash. That's just the way it goes right now. There's better news on the Intel side with the Sapphire Radeon RX 6800 XT 16 GB PULSE arriving with a near $200 saving over the 6800XT board from last month. With a street price of $1,329, it's over double the 6800 XT's $649 launch price. Dare we dream of normalized graphics card prices later in 2022? Here's hoping.

Anyway, Intel's new Alder Lake 12th-Gen chips are in the builds, specifically the i5-12600K, which is a pretty sweet CPU. It comes with 10 cores combined with Intel's new hybrid architecture. This is split into two types of cores; performance cores (six) and efficient cores (four). Foreground tasks are allocated to the performance cores while background tasks are set to the efficient cores in Intel's biggest architectural shift in a decade. The Alder Lake chips also integrate a one-click overclocking feature to the BIOS that helps users get more out of their systems. The max turbo frequency of this new chip is at 4.90GHz too, which is decent considering this chip is around $50 cheaper than the previous Intel Core i7-11700K.

Talking of the BIOS, the motherboard has to change to support the new CPU. MSI's PRO Z690 board supports this with its LGA1700 socket. It's a decent board, but to make things compatible, the budget had to be stretched—an extra $80 is the best we could do with the new chips. The EVGA SuperNOVA GA PSU was new last month and sticks around this issue.

GPU aside, things are pretty much as they were for the AMD build apart from a few price tweaks. The AMD Ryzen 5600X is $20 cheaper, for instance, which doesn't hurt. We've also kept the 750W EVGA SuperNOVA PSU for another month.

AMD INGREDIENTS

PART		PRICE	STREET PRICE
Case	Lian Li PC-011-Dynamic	$150	
PSU	750W EVGA SuperNOVA GA 80+ Gold	$108	
Mobo	Asus AM4 TUF Gaming X570 -Plus WiFi	$190	
CPU	AMD Ryzen 5 5600X	$260	
Cooler	280mm Cooler Master Masterliquid ML280 RGB	$55	
GPU	Gigabyte GeForce RTX 3070 8 GB GAMING OC **NEW**	$570	$1,199
RAM	16GB (2x 8GB) Team Vulcan Z CL18 @ 3600MHz	$63	
SSD	500GB Samsung 980 Pro NVME M.2 PCIe 4.0 SSD	$110	
HDD	2TB WD Blue 7200 HDD	$47	
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32	
Approximate Price:		**$1,585 or $2,214**	

INTEL INGREDIENTS

PART		PRICE	STREET PRICE
Case	Lian Li PC-011-Dynamic	$150	
PSU	750W EVGA SuperNOVA GA 80+ Gold	$108	
Mobo	MSI PRO Z690-A LGA1700	$209	
CPU	Intel Core i5-12600K	$300	
Cooler	Enermax Liqmax III 240 RGB	$50	
GPU	Sapphire Radeon RX 6800 XT 16GB PULSE **NEW**	$899	$1,329
RAM	16GB (2 x 8GB) Corsair Vengeance RGB Pro SL RGB CL18 @ 3600MHz	$99	
SSD	500GB Corsair Force MP600 M.2 PCIe 4.0	$90	
HDD	2TB WD Blue 7200 HDD	$47	
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32	
Approximate Price:		**$1,984 or $2,414**	

TURBO

LAST MONTH, the Alder Lake Core i9-12900K chip entered our high-end build and it's likely to stay there for a while. Right now, it's the world's fastest gaming chip, featuring a new hybrid architecture with performance and efficiency cores—16 in total with a 50/50 split between performance and efficiency. Compared with Intel's previous top offering, the Intel Core i9-11900K, it has double the core count and eight more threads than the 11th-Gen's 16 threads.

This chip is claimed to be up to 50 percent faster than the old Rocket Lake model. Even running on DDR4, it is still the world's best gaming CPU, so we had to put it in the build. The good news is that prices of the 12900K are normalizing near the 1000 unit tray price of $589 that Intel quotes. So, non-GPU component pricing is now near normal, with the exception of DDR5 memory.

We introduced a Z690 board last month but with some tasty DDR5 RAM. These two additions bump the price up, as is always the case with a new generation of memory. The Corsair Vengeance sticks come in at a hefty $300, but we hope this will drop soon. DDR5 is currently in short supply, so prices and availability are volatile.

As for the mobo, there's no change from the MSI PRO Z690-A WiFi LGA1700, an efficient board to support the new CPU and DDR5 memory. The same applies elsewhere, bar a few price tweaks, but the graphics card has changed. Out goes the ASRock OC Formula Radeon RX 6900 XT GDDR6 16GB, in comes the marginally cheaper PowerColor Red Devil RX 6900 XT Ultimate Gaming 16GB.

On the AMD side, we still can't justify the Ryzen 9 5950X at $720, so we stick with the Ryzen 9 5900X, albeit for a few dollars more than last month. Both machines come with Corsair's iCUE H150i Elite Capellix AIO, this 360mm cooler does a great job of keeping both of these high-performance chips cool. Also found on both setups are the same 6TB WD Blue 5400 HDDs—a great way to get a huge capacity secondary storage on both systems. The mid-range PSUs also stick around in the turbo builds. At $108, the 750W PSU offering from EVGA is hard to ignore with its 80+ Gold efficiency.

AMD INGREDIENTS

PART		PRICE	STREET PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220	
PSU	750W EVGA SuperNOVA GA 80+ Gold	$108	
Mobo	Gigabyte X570 GAMING X	$188	
CPU	AMD Ryzen 7 5900X	$499	
Cooler	Corsair iCUE H150i ELITE CAPELLIX AIO 360mm	$169	
GPU	MSI Gaming GeForce RTX 3080 LHR 10GB **NEW**	$700	$1,537
RAM	32GB (2x 16GB) G.Skill Ripjaws V 32GB @ 4000MHz	$135	
SSD	1TB Samsung 980 Pro M.2 PCIe 4.0	$160	
HDD	6TB WD Blue 5400 HDD	$106	
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32	

Approximate Price: $2,248 or $3,048

INTEL INGREDIENTS

PART		PRICE	STREET PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220	
PSU	750W EVGA SuperNOVA GA 80+ Gold	$108	
Mobo	MSI PRO Z690-A WiFi LGA1700	$240	
CPU	Intel Core i9-12900K	$619	
Cooler	Corsair iCUE H150i ELITE CAPELLIX AIO 360mm	$159	
GPU	PowerColor Red Devil RX 6900 XT Ultimate Gaming 16GB **NEW**	$999	$1,499
RAM	32GB (2 x 16GB) Corsair Vengeance DDR5 @ 5200MHz	$300	
SSD	1TB Gigabyte Aorus Gen4 7000s M.2 PCIe 4.0	$190	
HDD	6TB WD Blue 5400 HDD	$106	
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32	

Approximate Price: $2,973 or $3,473

Maximum PC (ISSN 1522-4279) is published 13 times a year, monthly plus a Holiday issue following the December issue, by Future US, Inc., 10th floor, 1100 13th Street, N.W Washington DC 20005, USA. Website: www.futureus.com. Periodicals postage paid at New York, NY, and at additional mailing offices. Newsstand distribution is handled by Curtis Circulation Company. Basic subscription rates: one year (13 issues) US: $30; Canada: US$30; Foreign: US$50. Canadian and foreign orders must be prepaid. Canadian price includes postage and GST (GST #R128220688). PMA #40612608. Subscriptions do not include newsstand specials. POSTMASTER: Send changes of address to *Maximum PC*, PO Box 2024, Langhorne, PA 19047, USA. Future US, Inc. also publishes *MacLife*, and *PC Gamer*. Entire contents copyright 2021, Future US, Inc. All rights reserved.

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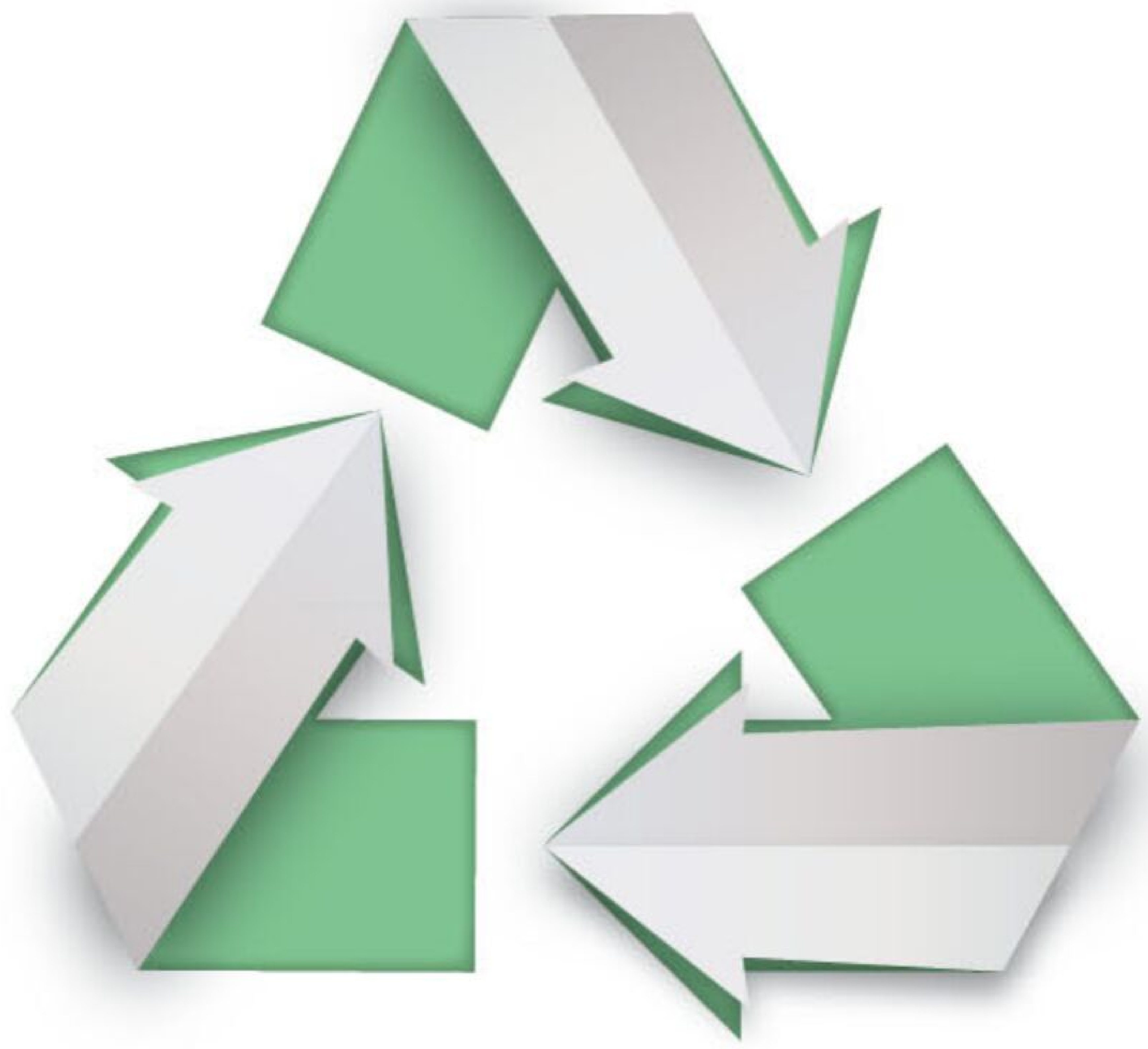

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